JOURNAL
OF THE
BOARD OF AGRICULTURE
OF
BRITISH GUIANA.

VOL. XX. JULY, 1927. No. 3.

A MESSAGE TO AGRICULTURISTS.

I wish to take this opportunity of expressing my thanks for the warm welcome which has been extended to me on all sides since my arrival in the Colony to assume the duties of Director of Science and Agriculture.

Following in the footsteps of such an illustrious predecessor as Sir John Harrison, I well recognize that much will be expected of me. I am confident, however, that with the co-operation and goodwill of the whole agricultural community coupled with patience and persistence, the difficulties will not prove insuperable.

It must be remembered that agricultural conditions in this country are unique in so far as the British Colonies are concerned, and the land problems to be solved are very different from those usually met with; it follows therefore that our requirements in certain directions will be different. This fact is not often sufficiently understood, hence progress has been relatively slow *vis à vis* many other Colonies of lesser size and importance.

It will be my constant aim and ambition to serve the agricultural interests of the Colony to the best of my ability, and I beg to assure you of my sympathy in the problems confronting us, and the assistance of both my staff and myself whenever such is needed. The Department after all is yours, and it is my earnest desire that you should make the greatest use of it.

Yours faithfully,
J. SYDNEY DASH.

July, 1927.

MEMORIAL TABLET

TO

SIR JOHN HARRISON.

"*Simplicity of character is the natural result of profound thought.*"—*Hazlitt.*

The ceremony of unveiling the Tablet erected to the memory of the late Sir John Harrison, by the officers of the Department of Science and Agriculture, was performed by His Excellency the Governor, Sir Cecil Rodwell, K.C.M.G., on the afternoon of June 14th, 1927, in the Botanic Gardens, Georgetown.

The occasion was marked by solemnity and a simplicity, in fit keeping with the character of him in whose honour all had assembled. In addition to His Excellency the Governor and his Aide-de-camp, Captain A. D. M. Stayner, there were present—the Hons. C. D. Douglas-Jones, C.M.G., (Colonial Secretary), Hector Josephs, K.C., B.A., LL.M., (Attorney-General), Dr. P. James-Kelly (Surgeon-General), R. E. Brassington, N. Cannon, J. Hampden-King, C.B.E., (Immigration-Agent-General). Messrs. W. Francis, F.I.C. (Acting Director, Department of Science and Agriculture), A. R. F. Webber, F.R., E. F. Fredericks, LL.B., F.R., A. E. Seeram, F.R., Colonel W. E. H. Bradburn (Inspector-General of Police), Major Bain-Gray Ph.D., B. Litt. (Commissioner of Education), Captain Edgar Beckett, F.L.S., Messrs. J. Wood Davis, A. D. E. Lauchlan, B.A., S. Bracewell B.Sc., R. A. Altson, B.Sc., S. H. Bayley, H. A. Britton, J. W. Mearns, J. J. da Silva, M. P. Camacho, A. T. Phillips, Dr. S. N. Bruce, the Misses A. Jardim, J. Pestano, and O. Bardon, Messrs. L. D. Cleare, Jnr., F.E.S., F.L.S., E. M. Peterkin, L. S. Davis, A. A Abraham, C. C. Dowding, W. H. Matthews, D. D. Blackman, T. Archer, J. N. Antrobus, D. Haynes, Indro Beharry, D. Iloo, J. Leitch, N. Persaud and C. L. C. Bourne.

The original idea of the officers of the Department was to present Sir John on his retirement with a piece of plate, suitably inscribed. His lamented death in February, on the eve of his retirement, made this impossible. It was decided to erect a Memorial instead, and permission having been obtained, it was resolved to erect a brass tablet, mounted on oak, and place it in position just below the clock erected to the memory of the late Government Botanist, George Samuel Jenman, F.L.S., his old friend and colleague.

The staff are grateful to Mr. J. Wood Davis, through whom the tablet was obtained, and take this opportunity of thanking him. For 36 years Sir John Harrison served British Guiana, he was the first Director of the Science and Agriculture Department, a position which he held for one and twenty years.

Mr. Francis opened the proceedings by asking His Excellency the Governor, on behalf of the officers of the Department of Science and Agriculture, to unveil the tablet.

His Excellency said that the occasion was not one which demanded from him any ornate or lengthy panegyric. Indeed, he could imagine few things more distasteful to him in whose honour they had assembled, than a laboured recital of his many achievements and virtues, but a brief reference might be permitted. Of his many achievements, probably there was none more valuable to British Guiana than his experiments in connexion with the Sugar Cane and the establishment of a Sugar Cane Experimental Station. It was proper that in these Gardens, where his experiments were carried on and where the first Experimental Station stood, they should put a final tribute to his memory. Of his many sterling qualities those which His Excellency believed chiefly impressed his contemporaries, and certainly were apparent even to those who only knew him slightly, and at the end of his career, were his devotion to duty, his singleness of purpose and his intolerance of anything that savoured of guile or duplicity. A notable figure in truth and a great servant of the Colony and of the Empire.

The Memorial he was about to unveil had been well chosen. In the severe simplicity of its style, it symbolised faithfully the character of the man whom it commemorated —a plain brass tablet mounted upon a plain slab of English oak. Of Sir John Harrison it might truly be said.

Illi robur et aes triplex

circa pectus erat x x x.

x x x

x x x x x

x x

x x x x x x

x x x x

x x x x x x

Quem mortis timuit gradum .

His Excellency then unveiled the memorial by drawing aside a Union Jack covering the tablet which bore the following inscription.

TO THE MEMORY OF
PROFESSOR SIR JOHN BURCHMORE HARRISON,
KT., C.M.G., M.A., F.I.C., F.C.S., F.G.S., F.G.S.A.,
DIRECTOR OF SCIENCE AND AGRICULTURE,
GOVERNMENT ANALYST AND GEOLOGIST,
WHO DIED ON THE 8TH FEBRUARY, 1926,
THIS TABLET IS ERECTED BY THE OFFICERS
OF THE DEPARTMENT OF SCIENCE AND
AGRICULTURE AS A TOKEN OF APPRECIATION
OF HIS STERLING ABILITY AND LONG AND
FAITHFUL SERVICE OF 36 YEARS TO THE
COLONY OF BRITISH GUIANA.

Mr. Brassington then said :—Your Excellency, ladies and gentlemen, I have been asked to move a vote of thanks to your Excellency for coming here this afternoon and unveiling the Memorial Tablet to Sir John Harrison. Perhaps it

would not be out of place for me to say that as a sugar planter of many years' experience, there was nobody in the profession—and I say Agriculture is a profession—who would deny that Sir John Harrison rendered invaluable service to the Sugar Industry. I do not think it is generally appreciated by the planters exactly, the full value of what his services were to the Industry. As your Excellency has so eloquently said, Sir John Harrison was a man who disliked anything that savoured of what one might call "frills." He was a tireless worker and there can be no doubt about it that his name will always be linked up with the scientific achievements in agriculture of his Department. On behalf of everyone here I desire to say we are very pleased to see your Excellency here this afternoon. You are, if I may so term it, the first practical agriculturist who has been Governor of this Colony, and you are giving a practical demonstration of that by what I may term going into the ranks of the local proprietors at your Plantation Cecilia at Enmore. We only hope that Your Excellency's plantation there will set an example in what may be done in other branches of agriculture than sugar, rice, coffee and cocoa. I again thank Your Excellency for attending here this afterooon.

Mr. Cannon then said :—Your Excellency I have been asked to say a few words in support of what Mr. Brassington has said. I do not think there is anything much I can add to what he has said. I think we all know the value Sir John Harrison was to this Colony and no words of mine can add to his deeds.

His Excellency then departed, and the gathering dispersed.

GROUND NUT CULTIVATION.

Visit To Governor's Model Plot.

His Excellency Sir Cecil Rodwell, K.C.M.G., attended by his private secretary, Lt. Colonel H. H. Johnson and accompanied by Professor J. Sydney Dash, Director of Science and Agriculture, paid a visit to his ground nut cultivation at Plantation Cecelia, Enmore, E.C., on Wednesday, the 27th July. Mr. C. C. Dowding, Resident Agricultural Instructor who inspects the cultivation, and Mr. E. Beckett, Agricultural Inspector, were also in attendance.

In response to an open invitation the following were present: Messrs J. Veerasammy, W. Mearns, C. H. Easton, H. L. Humphrys, C. C. Roberts, J. R. Muss, H. A. Thompson, J. J. T., J. A. and Colin Adams, S. E. A. Talbot, P. M. Walker J. L. Griffith, Fitz Greaves, H. W. Matthews, D. Profitt, H. M. Nehaul, J. Damon and Mrs. S. McGarell.

The Cultivation.

On the instruction of His Excellency, Mr. Dowding gave a description of the cultivation. He said that the area under cultivation was approximately two acres. It was divided into two sections. the east and west section. The eastern section was sub-divided into an eastern, middle and west portion.

The first two beds of the northern side of the east, middle, and west sub-sections were planted with the Virginia Runner variety at a distance of one foot apart in the rows, and 30 inches between the rows. The next four beds were also planted with the same variety, but at a distance of 18 inches in the rows, the space between the rows being the same. The remaining portion of the east sub-section was planted with the Chinese variety. These failed to germinate satisfactorily on account of the heavy nature of the sub-soil. Subsequently the area in question had to be replanted with the Virginia Runner variety at a distance of two feet in the rows, the distance between the rows being the same. The middle and western sub-

sections were planted with the Virginia Bunch variety at a distance of eight inches between the rows. Five small plots in the middle sub-section were also planted with the same variety at a distance of eighteen inches in the rows.

The entire western portion of the cultivation was planted with the Chinese variety in the following manner: on the southern side, twelve flat ridges were planted at a distance of one foot apart between the rows; one bed eleven feet wide, 18 inches apart; another of the same width, 15 inches apart; three of same width, one foot apart; eight beds, five feet wide, one foot apart; two beds, five feet wide, six inches apart; two thirty-inch flat ridges, six inches apart; and six thirty-inch ridges, one foot apart.

Preparation of Seeds.

With regard to the preparation of the seeds of the Chinese variety on the western portion, the treatment was as follows: They were soaked in water for 24 hours in order to soften the shell, taken out and allowed to drain for an hour and then planted in the shell. Some began to germinate on the eighth day and others never came up until the fourteenth. The seeds of the Virginia Runner and the Virginia Bunch varieties were soaked in formalin for four hours so as to destroy any fungi; they were then shelled and planted. The weather conditions were favourable and some of them began to germinate in 84 hours. The Chinese variety were shelled and planted on the northern portion of the east and middle sub-section; but owing to the fact that the land was very low, and had to be built up with sub-soil, the majority did not germinate; and the land had to be reforked and replanted with seedlings of the two other varieties. Great care was exercised in the selection of the seeds; and in the low and compact portions of the land, ridges had to be made. The width of the beds had also to be varied owing to the varying texture of the soil encountered.

Address by Director of Agriculture.

His Excellency then invited Professor Dash to speak, who said that he was pleased to come and see the great

effort His Excellency had made : it had certainly exceeded his expectation. He could only refer to matters in a general way. The best method was to learn by beginning.

He then gave a short impromptu talk on peanut cultivation, the substance of which is as follows :

In recent years there has been an increased demand for vegetable oils ; it has long been recognised, of course, that the peanut possesses considerable value from this point of view. The cultivation of the plant requires a fair amount of labour to handle it, especially if grown on a large scale. As there are several labour-saving implements, the labour bogey should not deter any one from engaging on its cultivation, provided the soil conditions for their efficient use exists.

The plant is a legume, and the only one of its kind that turns its flower into the soil after it has been fertilised. The reason for this peculiarity has not yet been determined. It has been fairly well established that the plant is a native of Brazil, and this would seem to indicate that it can be grown successfully in this colony ; whether economically or not is a matter for investigation.

It is cultivated largely in the United States and such British territories as the Madras Presidency and those in Africa, also in China and Japan. It is curious to note that the labour for handling the commodity in the African possessions is largely supplied from the neighbouring French territories.

In Africa, the question of freight, so far as exporting is concerned, is not as serious as in some countries owing to the comparative nearness of the market : hence the nuts are shipped in the shell which ensures a better quality. The possibility of shipping in compressed bales has been suggested in order to reduce space and consequently freight. The demand for peanuts in America is greater than the supply and imports are made from the East. The Americans consume a large quantity directly and convert the surplus into oil and peanut butter. In Europe the bulk of the imports is converted into oil.

SOIL.

The best soil in which to plant peanuts is a friable and light one—a sandy soil, as reaping is carried out more advantageously. Nuts grown on stiff clayey soils are discoloured and expensive to reap. Discoloured nuts have to be bleached where they enter into direct consumption, appearance being an important consideration.

Soils extremely rich in nitrogen are usually unsuitable, a large percentage of the pods of plants grown on such soils contain no nuts. It is essential that a proper balance of minerals be maintained, especially lime, in order that vegetative production may not take place at the expense of fruiting.

Peanuts should not be grown continually on the same soil. There should be proper rotation, or the yield of oil from the nuts may be diminished, and without rotation the crops are more liable to pests and disease.

In the case of the cultivation of pasture land, it will be noticed that a good crop of weeds springs up after ploughing. That is due to the fact that the seeds of such weeds are lying dormant in the soil waiting as it were for an opportunity. The best means of combating weeds is to smother them. While their germination cannot be prevented, the shading prevents them from obtaining light, and consequently they die. No cover crops apparently have been developed here so far as he had seen. Bengal beans make an ideal cover crop. Their stems and leaves could be turned into the land or used as fodder. In Trinidad they are now being tried for the purpose of taking the place of some of the grasses as fodder. While planting closely may often reduce the yields of plants generally, yet at the same time the weeds are materially kept down and at minimum cost. Peanuts may be planted either flat or in ridges, depending on the soil conditions. A point in favour of ridge planting is that the soil thereon is loose; but the ridges should be low and not too high so as to prevent excessive drying out of the moisture.

Harvesting.

Employers of labour should calculate before-hand the cost of labour, taking into account the kind of soil, the average ability of each labourer and the time in which the reaping can be completed. The work should be done rapidly and planting should be arranged with a view to ensuring suitable reaping weather. Harvesting in heavy rains ruins the crop by causing the nuts to germinate. The stems are relished by all classes of live stock and are used in several places as a substitute for hay.

Grading.

This is now being done in connection with all kinds of products. Agriculturists resent the idea of having their crops graded, but they are gradually being brought to recognise its value. As proof of the necessity of grading it may be stated that the contents of a bag or bale of any commodity is judged by the poorest sample and not the best, and it is useless to suppose that by mixing good and bad, the producer reaps any advantage in marketing. There should be the closest possible co-operation in such matters. It is practised to a large extent in the United States where co-operative methods in agriculture have increased by leaps and bounds, notably since the war. The number of associations has increased from approximately 6,000 in 1915 to double that number at the present time. The total volume of business transacted by them is roughly two and a half billion dollars. There are a number indeed which sell farm products annually to the extent of fifty million dollars each. Co-operation, in brief, is the exchange of ideas with beneficial results.

His Excellency then thanked Professor Dash for his address, which, he said, was interesting and illuminating although impromptu. He then asked the Professor if there were more varieties of nuts as he had been only able to get three. Professor Dash replied that the number was very limited only about four or five being listed. His Excellency also enquired about implements and was told that in the United States where the cost of labour was very

high, certain implements were used for harvesting and threshing.

Mr. Humphrys inquired whether the nuts could be planted during the slack seasons on the sugar estates.

Professor Dash said that the great point to consider was the planting of the nuts at a time which would ensure harvesting than in the dry weather.

Mr. Thompson said that a number of the small farmers had found their ground nut cultivation destroyed by red ants and wanted to know how the pest could be destroyed. In reply, Professor Dash said whenever new crops were reared, new pests were discovered, and he would be glad to see the specimens of the pest complained of. Travelling was difficult and expensive, and he would welcome the co-operation of the farmers in this respect. Mr. Beckett said that carbon bi-sulphide was effective and was being used at the present time.

In reply to a question by Mr. Colin Adams, Professor Dash stated that in St. Vincent the nuts were usually washed and thoroughly dried, but there the industry was entirely in the hands of the peasantry. Mrs. McGarell asked how long it was before the nuts were harvested.

His Excellency said jocularly that he could answer that question—the time was 4 to 4½ months.

Mr. Muss asked that apart from discolouration what was the difference in nuts produced in clay soils and those in sandy soil.

Professor Dash answered that he did not think there was much from a scientific point of view ; though economically, as he had said before, there was the difficulty of reaping.

THE RICE MOTH-BORER (*Diatraea saccharalis* F.,) AND RECOMMENDATIONS FOR ITS CONTROL.

By L. D. Cleare, Jnr., F.L.S., F.E.S.,
Government Economic Biologist.

The rice crop of the Colony has suffered somewhat within recent years from the attacks of an insect known as the Rice Moth-Borer, which in some districts has inflicted appreciable losses. This insect also attacks sugar-cane and is one of the well-known "borers" which causes severe damage to that crop, and which it has been proved is a difficult insect to control. The damage caused by this insect has increased recently, and unless steps are taken by all rice growers to combat the pest, it is believed that the loss inflicted by it will rise materially, and may affect seriously the production of rice in this colony. It is essential, therefore, that every effort should be made to control this insect when attacking rice.

The moth, which is a straw-coloured insect of about three-quarters of an inch in length, lays its eggs upon the leaves of the rice plant. From these eggs caterpillars emerge which bore into the rice stalks, and when fully grown measure about an inch long. It is this stage of the insect that causes the damage to the crop. Stalks that have been bored by the caterpillar may either break off and fall to the ground and thus fail to produce flowers and grain, or, if the flowers have already formed, they will fail to produce grain. In this way many stalks that would otherwise produce grain fail to do so, with a consequent reduction in the yield of paddy.

As the result of investigations recently undertaken the following preliminary recommendations have been drawn up for combating the pest.

In districts where two crops of rice are grown a year, and which possess an adequate and dependable water supply, it is recommended that the stalks should be cut

low, within a few inches of ground, at the time of harvesting the crop. The fields should then be flooded again immediately after harvesting, so that the remaining stubble it submerged. Or, if the paddy is cut short when reaping, and long stalks consequently left standing in the fields, these should be cut within a few inches of the ground immediately after harvesting has been completed, by means of a scythe or other implement, and the fields, together with the stalks thus cut down, then submerged as before.

In districts where only one crop of rice is grown it is recommended that, if the old stools do not die readily, they should be ploughed out. The fields, if left fallow after reaping, should be ploughed again at least two weeks before planting in order to remove and bury all heavy grasses and "volunteer rice" and then completely submerged in water. The planting of a suitable crop as a rotation between two rice crops is also recommended. This not only would aid materially in the control of the moth-borer, but would improve the condition of the soil and make for larger yields. There would be the additional advantage of the production of another crop during the period that the land would otherwise lie idle. A suitable crop for such rotation would be a pulse, and for this purpose either Green-Gram or "Mung" *(Phaseolus mungo)*, "Black Eyes" (*Vigna sinensis*, var.) "Increase Pea," or some similar pea is suggested.

Rice straw, after the separation of the paddy therefrom, should be returned to the beds and, either ploughed into the soil, or, after first damping it at the "mashing out" places, or "carians," should be submerged in the bed. The burning of rice straw after the separation of the grain is not recommended as a method of disposal of this material, although it is now practised in most parts of the colony. When practised over a number of years there can be little doubt that this method of disposal of rice straw seriously affects the yields of the crop, as may be observed already in some rice growing areas on the coastlands.

"COCKLES" IN THE NORTH WESTERN DISTRICT.

In July, the Government Economic Biologist visited the North Western District in connection with a report of an outbreak of "cockles." A number of farms in the district were seen and investigations carried out on the insect. Mr. Cleare reports that the insect concerned is a beetle, *Ligyrus ebenus* De G., which at times also causes injury to sugar-cane on the coastlands although of comparatively minor importance to that crop.

The principal crop affected in the North Western District, was Tannias, which are extensively grown in that district, and at the time of the visit it was the adult insect that was causing the damage. The beetle bores into the sets or "bottoms" soon after they are planted, thus inflicting serious damage and often completely destroying them. For this reason planting is, as a rule delayed, and the farmer seriously handicapped.

Investigations revealed the fact that the insects are also injurious in the larval stage, known as "white worms" in the district but more correctly "white grubs," but at the time this stage had already been passed, and, as already mentioned, only adults were to be found. It was also observed that White Tannias appear to be less injured than Yellow Tannias, although not entirely free from attack.

Owing to the lateness in the season, investigations could not be further pursued, and it is proposed to visit the district early next year in order to continue inquiries into the insect. In the meantime, a number of adults have been secured, and laboratory investigations on the pest are being undertaken.

THE CULTIVATION OF CITRUS FRUITS.

Mr. H. Harold Hume has recently issued a new text book bearing the above title. It is published by Macmillan & Co., and the price is one guinea. The subject is of such importance at the present time that opportunity is being taken to review the book at some length and to offer such comments as may appear necessary in dealing with the subject matter in special reference to tropical conditions.

The volume is intended to take the place of a previous one—Citrus Fruits and their Culture—by the same author. The new work embodies many of the useful features of the old, but covers the ground more thoroughly as a result of the knowledge gained since 1904. The volume may be regarded as an up-to-date treatise covering every phase of citrus activity. Indeed, there is hardly any text book of tropical import recently issued which will be read with greater interest and appreciation. No pains have been spared to make it both comprehensive and authoritative, and although primarily for Florida conditions, it can be recommended with confidence as a general text book on the subject of citrus.

Students of the botany of citrus and the variety question generally will find in the treatment of the subject a considerable improvement on the older work, the chapter on limes being perhaps the only one which might have received fuller attention in view of the importance of finding varieties resistant to the Wither-Tip Fungus and to which only very scant reference is made.

In respect to commercial citrus varieties, emphasis is laid on the change towards simplification especially in the matter of numbers with a view to greater uniformity of product, while such factors as season of ripening, market quality, resistance to pests and diseases are receiving greater

consideration than they have in the past. In Florida the following varieties are now favoured :—

Sweet Oranges: Parson Brown, Hamlin, Pineapple, Valencia, Lue Gim Gong.

Mandarin Oranges: Satsuma, Dancy, Temple and King.

Grapefruit: Triumph, Duncan, Marsh Seedless, and McCarty.

The McCarty grapefuit is highly recommended as being of excellent quality, and it also has the very desirable feature of producing its fruit singly and not in bunches, thus ensuring a good exterior appearance. The presence of seeds in grapefruit, it is pointed out, makes little difference from the consumer's point of view, but may be objectionable if the fruit is to be held very late on the trees as the seeds may germinate and spoil the flavour. Useful information on judging citrus fruits follows the discussion on varieties.

Propagation methods are adequately dealt with in a book of this size, one chapter being devoted to stocks for citrus, mainly sour orange, rough lemon, trifoliate orange, pomelo and sweet orange. In regard to the question of bud variation, reference is made to the work of Shamel and his associates in California, which has served to emphasize the need for care in bud selection. At the same time, some of the conclusions reached have been questioned by a number of leading horticulturists, it being clear that all variations cannot be attributed to bud sports ; variability in size and shape of fruit, thickness of peel, colour, seediness, vigour and yield, noticeable in whole trees, parts of trees or single branches may be brought about by differences in stocks, moisture, soil, food supply, and many other imperfectly understood environmental factors. Many more years of experimentation will be necessary before definite conclusions can be reached on all the points involved ; in other words, we have here the old problem of differentiating between true variations and fluctuations due to environmental factors. In the meantime, however, the grower cannot afford to be lax in his efforts to propagate only from the most carefully selected scions.

The discussion on soils, location, preparation and planting, contain much sound advice and instruction which should be appreciated especially by beginners in the art of citrus culture ; the importance of wind-breaks is stressed, and in this connection it may be noted that in Florida the bamboo, Camphor tree and Casuarina find a place.

Dealing with the cultivation of citrus groves, we note with pleasure the author's condemnation of clean culture as opposed to such measures that have for their object the maintenance of the soil humus. Under tropical conditions, clean cultivation and no attention to the vegetable matter content of the soil inevitably lead to disastrous results ; the trees become debilitated and prone to numerous pests and diseases. In Florida, cultivation along with the free use of cover crops appears to be the safest practice. The plants recommended are beggarweed (*Desmodium tortuosum*), *Crotalaria striata* and *C. retzii* and a non-climbing velvet bean (*Stizolobium* sp.).

There is perhaps no tropical orchard crop that responds so readily to fertilizer treatment as citrus, and the author's recommendations should be carefully studied. In connection with sources of plant food, he rightly points out that stable manure should be used with caution, indeed any organic nitrogenous manures as they are not usually well-balanced and need additions of minerals, notably potash, for best results. Unbalanced manures are apt to produce thick-skinned fruit, full of rag, insipid, and lacking in character. On the other hand, stable manure may be of great assistance in putting new growth into starved and neglected trees. Of commercial fertilisers, nitrate of soda and sulphate of ammonia alternately as sources of nitrogen, ground bone and acid phosphate supplying phosphoric acid and the sulphates of potash have given the most satisfactory results in Florida. For young trees, a fertilizer containing 6 per cent. phosphoric acid, 9 per cent. potash and 4 per cent. ammonia is necessary and for bearing trees one containing 8, 10 and 3 per cent. respectively. On poor soils, a half pound of fertilizer for each young tree should be incorporated at the time of planting, followed 4 months later by an additional pound ; these amounts may be increased

in the second year and until bearing stage is reached. When fruiting begins the formula should be changed to the one advised for bearing trees. Thus, trees producing 10 boxes of fruit should receive 30 to 50 lb. of the mixture each.

Under more tropical climatic conditions than Florida, where there are heavy rains and high soil temperatures with attendant leaching of fertilizers and rapid destruction of organic matter, the whole aspect of economic treatment of commercial citrus orchards with special reference to manures and maintenance of fertility will need careful thought and investigation. At any rate the most successful tropical orchardists have learned fully to appreciate the value of the organic mulch as an important factor in the permanent health and productivity of their trees. Its efficiency naturally depends on the frequency of renewal, and where green crops cannot be successfully grown in the orchard to produce the necessary quantity, it has often been found practical to utilize waste areas adjoining in the growing of grasses and such material as can be easily brought in for the purpose. Where such conditions are maintained the addition of mineral fertilizers (phosphates and potash) is much more likely to be profitable. Finally, while clean cultivation cannot be regarded with favour, every effort should be made to prevent the formation of turf in the orchard, to which the roots of most citrus trees are intolerant.

The pruning of citrus does not assume the same importance as is the practice with many other fruit trees, the early stages of growth requiring most attention in regard to this operation; that is, the time when the general shape of the tree is being considered—whether a high or low-headed type is the object in view. While extremes in either direction are to be avoided, low-headed trees possess, economically speaking, many advantages over tall trees. These points are succinctly discussed in a short chapter of the book under review.

Handling the citrus crop, as is natural to expect in a work of this kind, receives fairly complete treatment; and while there is nothing new to note under such topics as

picking and picking equipment, we would commend for study, particularly by those new to the subject, the pages dealing with packing and handling—washing, drying, grading, and colouring—at the packing houses. An important change has been the disappearance of the small individual packing house and the development of larger plants, resulting in standardization of methods and greater uniformity in the final product.

The old plan of sweating or curing oranges and grapefruit has been abandoned, the fruit being handled now as rapidly as possible ; the only curing the fruit may receive occurs during temporary stoppages or in transit. The bulge pack has been evolved to make good any slackness from curing shrinkage after packing. When finished, the fruit in a well-packed box is practically level at the ends, but at the centre it is sometimes up one to one and one-half inches above the sides of the box, even two and one-half inches being permissible. In getting this bulge, advantage is taken of a slight variation in sizing the fruit, the larger fruits being worked towards the centre of the box.

Four chapters on pests and diseases with methods of control in practice complete the book. The reviewer has not thought it necessary to refer in detail to irrigation and frost considerations, both of which subjects find a place in its pages. The volume is efficiently illustrated and well-printed and is assured of a prominent place on the bookshelves of all those interested in citrus culture.

J. SYDNEY DASH.

THE PRINCIPAL VARIETIES OF SUGAR CANE IN BRITISH GUIANA UNDER CULTIVATION DURING 1925, 1926, 1927.

By the Director of Science and Agriculture and the Secretary of the British Guiana Sugar Planters Experiment Stations Committee.

Variety.	1925.	1926.	1927.	Increase or Decrease on 1925.	
	areas	in British	acres.	Increase.	Decrease.
D. 625	37,413	39,193	40,689	1,496	
Bourbon	323	362	257		105
D. 625 mixed with Bourbon & other seedlings	9,201	8,300	8,576	276	
D. 145	2,649	2,854	2,370		484
D. 118	1,576	1,891	2,057	166	
R. P.8	461	285	232		53
B. H. 10 (12)	190	226	217		9
B. 208	403	204	184		20
D. 109	127	116	164	48	
P.L. 2	103	139	105		34
Diamond 37	316	154	69		85
Diamond 10	5	34	65	31	
D. 419	84	70	63		7
Diamond 581	55	29	29		
D. 167	51	37	19		18
Small areas under other varieties & areas under varieties unenumerated	433	206	93		113
Total Estates' Canes	53,390	54,100	55,189	2,017	928
Total Farmers' Canes *	3,800	3,400	3,400		
Totals	57,190	57,500	58,589	1,089	

* *Includes* areas at Plns. Hope & Anna Regina.

The following table indicates the relative distribution of the various kinds of cane during the crops of 1921 to 1927 inclusive.

Variety.	For Crops of						
	1921.	1922.	1923.	1924.	1925.	1926.	1927.
D. 625	56·5	59·4	65·4	70·4	70.1	72.5	73.7
Bourbon	3·5	2·5	2·7	0·7	0·6	0.6	0,5
D. 625 mixed with Bourbon and other Seedlings	13·9	15·2	11.5	13·5	17·2	15.5	15.5
D. 145	7.5	7·3	7·1	6·6	4·9	5.2	4.3
D. 118	4.8	4·1	3·6	3·1	2·9	3.5	3.7
R.P. 8	1·6	1·3	1.5	1·0	0·9	0.5	0.4
B.H. 10 (12)	0·2	0·3	0·4	0·6	0·3	0.4	0.4
B. 208	3·4	3.0	2.0	1.2	0·8	0.4	0.3
D. 109	0·5	0.5	0·3	0·2	0·2	0.2	0.3
P.L. 2	—	0·1	0·1	0·1	0.2	0.2	0.2
Diamond 37	0·2	0.3	0·6	0·7	0.6	0.3	0.1
D. 419	2·7	1.6	1·1	0·2	0.1	0.1	0.1
Diamond 185	1·3	1.0	0.9	0·3	—	—	—
Ba 6032	0.3	0·4	0·5	0.3	—	—	—
Small areas under other varieties, and areas under varieties unenumerated.	3·6	3·0	2·3	1·1	1·2	0.6	0.5
	100.0	100·0	100·0	100·0	100.0	100.0	100.0

From the returns supplied by the Sugar Plantations, the distribution of the various sugar canes in cultivation for the crops of 1921 to 1927 inclusive, according to their origin is as follows:—

Variety.	1921	1922	1923	1924	1925	1926	1927
Bourbon and other old Varieties	8·8	8·2	9·2	4·8	5·1	5.0	4.2
Java	1·1	0·4	0·1	0·1	0·1	—	—
Barbados	4·4	4·1	3·2	2·2	1·4	1.0	0.7
British Guiana :—							
Plns. Diamond & Providence	3·3	3·5	3·7	2·6	2·2	1.2	0.9
Botanic Gardens	82.4	83·8	83·8	90·3	91·2	92.8	94.2
	100·0	100·0	100·0	100·0	100·0	100.0	100.0

The average yields in tons of commercial sugar per acre of the principal varieties reaped during the crops of 1922 as deduced from the returns supplied by the managers of the sugar plantations were as follows :—

	Plantations		Tons Sugar per Acre	
	No. Reporting	Areas reported in acres.	Mean	Maximum
D. 419	2	68	2.30	3.00
B. H. 10 (12)	3	166	2.26	2.54
D. 118	8	1,556	2.07	2.36
Diamond 37	2	133	2.05	2.17
R. P. 8	2	247	2.00	2.17
B. 208	3	183	1.94	2.28
D. 145	11	2,345	1.84	2.36
*Mixed	13	6,832	1.78	2.70
D. 625	26	35,298	1.67	2.84
Bourbon	3	253	1.67	2.20

*D. 625 mixed with Bourbon and other seedlings.

Owing to the severe drought and to difficulties in securing a fair supply of labour, many of the smaller plantations had not been able to keep up their cultivation as they would otherwise have done, with the result that their crops were short. It is desirable to record separately the results supplied by the managers of the larger and hence more favourably situated plantations. The results were :—

	Plantations		Tons Sugar per Acre	
	No. Reporting	Areas reported in acres	Mean	Maximum
B. H. 10 (12)	3	166	2.26	2.54
D. 118	8	1,556	2.07	2.36
B. 208	3	183	1.94	2.28
D. 625	18	30,979	1.89	2.84
D. 145	11	2,345	1.84	2.36

The results of large scale field trials with other varieties on the sugar plantations are shown in the following table :—

Variety	Acreage	Yield
Diamond 10	32	3.67
Diamond 581	27	3.11
D. 109	78	2.10
Ba. 6032	48	2.10
D. 167	35	2.03
D. 199	15	1.74
Green Transparent	14	1.69
P. L. 2	87	1.25

KOKERIT FRUITS FROM BRITISH GUIANA.

In a report published in this *Bulletin* (1916, **14**, 8) an account was given of an investigation at the Imperial Institute of the pericarp oil, the kernel oil and the kernel meal obtained from a sample of kokerit (or cokerite) fruits sent from British Guiana. The fruits were identified at the Royal Botanic Gardens, Kew, as those of a species of *Maximiliana*, possibly *M. regia*. The Conservator of Forests, British Guiana, has recently informed the Imperial Institute that the fruits examined in 1916 were obtained from palms growing in the Botanic Gardens at Georgetown. As there was some doubt as to the botanical identity of the palms from which these fruits had been collected it was considered desirable to send further specimens for investigation, and these were received at the Imperial Institute in September, 1926. They had been obtained from the forests bordering the Berbice river and about 50 to 60 miles from the coast, and consisted of about 1 cwt. of whole fruits and a quantity of nuts which had been collected from the ground under the palms, and from which the pericarp had been eaten off by animals. In forwarding the samples the Conservator of Forests stated that one whole bunch of the fruits weighed 115 lb., of which 88 lb. consisted of fruits and the remainder of bracts, etc.

Specimens of these fruits were also submitted to the Royal Botanic Gardens, Kew, for identification. The Imperial Institute is informed that although the palm appears to be one which is grown in Botanic Gardens under the name of *Maximiliana regia*, there is some doubt as to its exact identity and that the authorities at Kew are endeavouring to procure type specimens with a view to deciding the question.

The material received last year was as follows :—

Fruits.—These consisted of pale to dark brown fruits in a moist condition. They were pointed at the apex and rounded at the base, 2 to $2\frac{1}{4}$ in. long and $\frac{3}{4}$ to 1 in. in diameter at the widest part; the base was covered

with thin papery perianth segments. The fruits were identical in appearance with those previously received.

Each fruit consisted of pericarp, nut and kernels. The pericarp was tough and fibrous externally, but the inner portion was soft and oily. The nuts were pale brown, $1\frac{1}{4}$ to $1\frac{3}{4}$ in. long and $\frac{3}{4}$ to 1 in. in diameter at the widest part. They had a very hard, thick, woody shell enclosing from one to three kernels, but usually two. The kernels were long, narrow, oval and flattened. They were from 0·8 to 1·2 in. long and 0·4 to 0·5 in. broad at the widest part. The interior of the kernel was nearly white and resembled that of palm kernels in consistency.

Nuts.—This sample consisted of nuts similar to those described above. A small amount of the pericarp remained attached to the shell.

The fruits were submitted to detailed examination with the following results.

	Grams
Average weight of a fruit	12·0
Average weight of a nut	8·7
Average weight of a kernel	1·1

Average composition of a fruit:	*Per cent.*
Perianth segments	10·4
Pericarp	17·4
Shell of nut	56·9
Kernel	15·3
Average composition of the nut:	
Shell	78·8
Kernel	21·2

Examination of Pericarp

The pericarp contained 20 per cent. of moisture and on extraction with light petroleum yield 10.1 per cent. of oil, corresponding to a yield of 12.6 per cent. from the moisture-free material, and to 1·8 per cent. from the whole fruits. The oil thus obtained was a dark reddish-orange liquid which had an odour resembling that of palm oil (the pericarp-oil of the fruit of the African oil palm) and on standing deposited a large quantity of stearins.

The oil was examined with the following results which are shown in comparison with those previously obtained at the Imperial Institute for the oil from the pericarp and with those recorded for palm oil.

—	Kokerit pericarp oil		Palm oil.
	Present sample.	Previous sample.	
Specific gravity at 100/15° C.	0.8590	—	0·859–0·862
Refractive index at 40° C.	1·4575	—	1·4531–1·4559
Solidifying point of fatty acids ... °C.	23·8	25·5	43–45
Acid value	70·1	28·6	20–160
Saponification value	206·9	211·6	198–200
Iodine value (Hübl. 17 hrs.) ... *per cent.*	56·1	51·4	52–57
Unsaponifiable matter ... *per cent.*	2·3	—	—
Soluble volatile acids[1]	0·55	—	0·86–1·87
Insoluble volatile acids[1]	2·65	—	—

[1] *cc. of N/10 KOH required to neutralise the acids from 5 grams of oil.*

Examination of Kernels

The kernels contained 18·7 per cent. of moisture, and on extraction with light petroleum yielded 54·6 per cent. of oil, corresponding to yield of 67·2 per cent. from the moisture-free kernels, and to 11·6 per cent. from the nuts or 8·4 per cent. from the whole fruits. This oil was

—	Kokerit kernel oil.			Palm kernel oil.
	Present sample.	Previous sample.	Bolton and Hewer.	
Specific gravity at 100/15° C.	0·8673	0·867	—	0.873
Melting point ... ° C.	28·2	27·0	26·0	21-24[1] 26-29[2]
Refractive index at 40°C ...	1·450	—	1·4513	1·4495–1·4710
Solidifying point of fatty acids ... ... ° C.	25·5	24·2	—	20–25·5
Acid value	2·6	3·1	1·0	5–22
Saponification value ...	248·5	253·0	240·19	245–248
Iodine value (Hübl. 17 hrs.) *per cent.*	10·5	13·0	16·56	14–17·5
Unsaponifiable matter *per cent.*	0·3	0·3	—	below 0·5
Soluble volatile acids[3] ...	6·5	3·0	—	5–7·6
Insoluble volatile acids[3] ...	11·6	7·0	—	10–12

[1] *Open tube method.*

2 *Complete fusion.*

[3] *cc. of N/10 KOH required to neutralise the acids from 5 grams of fat.*

a cream-coloured, fairly hard fat with an odour resembling that of coconut and palm kernel oils.

The oil was examined with the results shown on page 3, which are shown in comparison with those previously obtained for the kernel oil at the Imperial Institute, with those obtained by Bolton and Hewer for kokerit kernel oil (*Analyst*, 1917, **42**, 35), and with those recorded for palm kernel oil.

Examination of Residual Meal From Kernels

The meal left after the extraction of the kernels with light petroleum was pale pinkish-white and almost devoid of taste and odour. The results of the chemical examination are given in the following table together with the corresponding figures for the earlier sample of kokerit kernel meal, and with those for palm kernel cake. For convenience of comparison the results are calculated for cake containing 7 per cent. of fat, the average amount present in commercial feeding cakes.

—	Kokerit kernel meal.		Typical (English-made) palm kernel cakes examined at the Imperial Institute.	
	Present sample.	Previous sample.		
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	13.2	8.6	9·5	10·8
Crude proteins	16·1	15.0	18·0	17·3
Fat	7·0	7·0	7·0	7·0
Carbohydrates, etc. (by difference	48·6	52·5	51·3	51·9
Crude fibre	10·3	12·6	10·2	9·6
Ash	4·8	4·3	4·0	3·4
Nutrient ratio	1 : 4·0	1 : 4·4	1 : 3·7	1 : 3·9
Food units	106	108	114	113

The meal was found to be free from alkaloids and cyanogenetic glucosides.

General Remarks

In appearance and composition the present kokerit fruits resembled those received previously but were slightly larger. The pericarp contained rather less oil, viz., 12·6 per cent. as compared with 17·1 per cent., calculated in each case on the moisture-free material. The oil extracted

from the pericarp resembled that obtained in the previous case and gave similar results on examination.

The kernels of the present sample contained rather more oil than those of the earlier sample, viz., 67·2 per cent. as compared with 64·1 per cent., calculated on the moisture-free material. The oil closely resembled that from the kernels of the previous sample both in appearance and constants except that the amount of soluble and insoluble volatile acids was rather higher.

The composition of the residual meal closely resembled that obtained in the previous investigation.

In view of the similarity in appearance and composition of the present kokerit fruits to those received previously, there can be little doubt that they were derived from the same species of palm.

The pericarp oil from kokerit fruits resembles palm oil in appearence and analytical constants, with the exception of the solidifying point of the fatty acids, which is much higher in the case of palm oil. The high acid value of the oil from the present sample was no doubt due to the fruits having been shipped in a moist condition. This pericarp oil, if available in commercial quantities, would probably realise a price somewhat below that of ordinary palm oil, which is quoted at £35 10s. per ton, spot, Liverpool (March, 1927). In view, however, of the comparatively low percentage of oil in the pericarp it seems doubtful whether its extraction on a commercial scale would be remunerative.

The kokerit kernel oil closely resembles palm kernel oil both in appearance and in chemical constants and should be readily saleable in this country as an edible fat at a price approximating to that of palm kernel oil, which is quoted in Liverpool at £37 10s. to £38 per ton (March, 1927). As the kernels form only a small percentage of the fruits and nuts (15·3 per cent. of the former and 21·2 per cent. of the latter) it would be necessary to separate the kernels in British Guiana in order to reduce the cost of transport. If the kernels could be delivered whole and in an undamaged condition they would probably realise about the same price as palm kernels, which are quoted

in Liverpool at £19 10s. per ton, spot (March, 1927). Some difficulty may be experienced in separating the kernels whole from the nuts as they are easily broken on cracking the very hard shell. It seems possible, however, that the operation could be facilitated by submitting the nuts to steam heat (as is now done in the case of palm nuts to cause the kernels to shrink away from the shells) and then cracking them in a suitable machine. If the kernels could not be shipped in a whole and undamaged condition it would be necessary for them to be crushed in British Guiana.

The residual meal from the kernels is slightly inferior to palm kernel cake as a feeding stuff, and would probably realise a somewhat lower price than the latter which is quoted in liverpool at £7.10. per ton. If the kernels were crushed in British Guiana it would probably not be profitable to export the cake to the United Kingdom, but a local market might perhaps be found for it.

THE LARGE BLACK PIG.

By E. Walford-Lloyd.

It is not only in England that Large Blacks are popular, for they have been found to be the ideal pig in many hot climates, being less subject to atavism. In nearly every pig-breeding country of the world one now finds the breed well established. In Spain they are well known, and they are equally well known in Portugal. Italy, too, has an appreciable number of Large Black herds, while in Holland are to be found some keen supporters.

In British East Africa, Large Blacks are in great favour, not only for keeping pure, but for crossing on Berkshires; but as more knowledge of the pig industry is being gained in that country, breeders are there more inclined to stop cross-breeding and to keep the breeds pure.

Of late years Peru has shown a great interest in pedigree stock, especially sheep and pigs, and the Peruvian

Government have started a pure-bred herd of Large Black pigs at their Experimental School with a view to showing Peruvian farmers that the Large Black is the utility pig for that climate. Brazil is also keenly interested in Large Blacks, and there should be a great future for the breed.

The secret of making pig-breeding pay now-a-days is early maturity, enabling the breeder to get them off his hands at the earliest possible moment. To this must be added prolificacy, for sows giving only three or four pigs at a litter cannot possibly pay their way.

As regards fecundity, the Large Black sow is preeminent. She can produce a big litter, and being possessed of deep milking abilities, she makes an excellent mother, rearing her pigs with uniform success and doing them well ; while at the same time she is most docile with them.

Perhaps the greater majority of herds of Large Blacks are kept on the open-air system, and where this is carried out and where sows and litters have free access to grass or woodland runs, the pigs look, and are, much the healthiest and best ; and those who have the greatest experience in breeding Large Blacks consider that the more pigs have a free range, the better they do, with the exception of fattening pigs, which, of course, are best shut up for the last six to eight weeks of their lives.

The outdoor, hardy, grazing pig is the economical pig to keep ; and as grazers, Large Blacks are unsurpassed for being docile and quiet, it is not half as much trouble to keep Large Blacks within bounds as it is with some other breeds. Whether it be out on the pastures in sunshine, or folded on kale and catch crops generally, in muddy weather, heavy rain, or even snow, the Large Black will continue to flourish, a fact that indeed is a practical testimony to its grand constitution.

Large Black breeders are firmly convinced that there is less shrinkage between live and dead weight in their breed than in any others ; and as a proof of this it may be quoted that in a well known herd over a long period of years, the shrinkage from live to dead weight has averaged only 20 per cent. and even been lower.

The meat of the Large Blacks is in no way coarse, and the pork, while not too fat is of good flavour. As bacon pigs they turn out the three qualities known to the trade as "lean sizeable," "medium" and "fat," while they are eminently suitable for the production of Wiltshire bacon.

A well-known breeder of Large Blacks has given his opinion that, provided a suitable ration has been fed, the average Large Black gilt or sow is capable of carrying on her pigs in a healthy, thriving condition until they are ten or twelve weeks old. As Large Blacks are very fast growing pigs, they should be carefully fed with nourishing food at the age of from 14 to 18 weeks, for it is then that their physical needs may have outstripped their appetite, *thus making it necessary to choose the rations carefully.* This same breeder has also stated that the Large Black sow, on account of her great qualities, is often expected to do too much on too little, but like any good-doing breed, they pay well for generous treatment. If a herd of this breed is run on sound and economic lines, Large Blacks of good strain, well fed, are practically always fit to go to the butcher after weaning,

The British Climate is noted for its variable weather and, therefore, it is of the greatest importance that the farmer should obtain a pig which can withstand long spells of cold and damp. In the Large Black he possesses just that pig, for they can be kept out of doors in all weather, provided only that they have a dry bed to sleep on at night. It must not be imagined, however, that the breed can exist upon grass and nothing else, for although a Large Black gilt or sow can make excellent use of rough food, yet, being prolific and a heavy milking animal, it must be fed well before the birth of the litter and also after the arrival of the small pigs to keep up the supply of milk and to prevent the sow being worn down. *Breeders Directory. 1926—7*

THE GRASSLAND CONFERENCE AT CAMBRIDGE.

A. B. Bruce, M.A., Dip. Agric. (Cantab.)

Reprinted from the Journal of the Ministry of Agriculture.—Vol. XXXIV. No. 3.

The Ministry of Agriculture made a happy choice in selecting grassland as the subject of its third conference of Agricultural organizers. Grassland husbandry is of great topical interest—in view of the unchecked decline in arable land which recent statistics show, it could not well be otherwise—and it is a fortunate coincidence that, as Professor T. B. Wood pointed out, scientists are now entitled to present a philosophy of grass husbandry. That is to say, recent discoveries at Cambridge and, we must add, at the Rowett Institute at Aberdeen, as well as a Aberystwyth, justify scientists in giving precise scientific reasons upon which a definite rationale of the economic treatment of grassland can be based.

The Conference was attended by upwards of one hundred persons—agricultural organizers, teachers, research workers and practical agriculturists. The proceedings opened with a dinner at Gonville and Caius College on April 7, at which the Minister delivered an address dealing with the administrative and financial outlook of agricultural education and research. On behalf of the University and College authorities, Professor Buckland, President of the College, replied in a witty speech. The health of the Minister was proposed by the senior county organizer present, Mr. T. Hacking, of Leicestershire.

It is not proposed to give here a complete account of the proceedings during the following days. It will be sufficient to present a reasoned summary and to indicate a few of the significant features of the interesting contributions made to the discussions that followed the reading of the papers.

The Role of Mineral Substances in Nutrition.

On the forenoon of April 8 the Conference had the privilege of having for its chairman Sir F. Gowland Hopkins, F.R.S., whose world-wide reputation as a pioneer in the domain of bio-chemistry needs no emphasis here. A discussion on the rôle of mineral substances in nutrition was opened by Dr. J. B. Orr, Director of the Rowett Institute. He reviewed the present position of knowledge on the subject, including some account of recent discoveries made at Aberdeen. Up to quite recent years, the science of animal nutrition has been wholly concerned with what may be termed the grosser requirements of the animal in respect of the energy and repair balances as measured by its needs in proteins, carbohydrates and fats. The speaker, while emphasizing the continuing importance of these requirements —especially of the protein fraction—pointed out that the presence of definite, though small, quantities of "ash" substances are indispensable for the activation of the protein and carbohydrate constituents. Their absence or lack of balance may be the cause of malnutrition and the proximate reason, therefore, of disease, and that, in its turn, must react on the economic assimilation of the grosser body-building constituents.

As a guide to the absolute as well as the relative proportions in which mineral substances are needed for the health and working of the animal economy, Dr. Orr drew attention to the composition of the milk of animals in which the farmer is interested. The facts of evolution require that the food of the herbivores should show a close relation to the constitution of their natural food, that is, herbage ; and as an index of the food requirements of any species, milk—the natural food of the young of that species—is the best index. When we study the natural food of herbivores, we at once recognize that natural conditions permit of a free range, whereas domestication for the purposes of man inevitably leads, if not to complete at least to a partial restriction of choice of diet. The importance of this consideration is brought home to us, also, when we consider two classes of inter-related facts which recent observation and experiment have brought to light.

First, actual analysis of herbage has shown that the mineral contents of natural grass vary from locality to locality; and, secondly, that the instincts of wild animals can be correlated with the presence or absence of certain minerals in the food they choose. Thus the migratory instinct, by force of which herbivores change their grazing grounds, can generally be correlated with mineral requirements. Again, depraved appetite (now known as *pica*), such as the eating of excreta and carrion, has been shown to be due to the absence of particular minerals in the ordinary diet. Of the latter, perhaps the most striking instance can be given from the investigations of Theiler in South Africa. Cattle pasturing in the veldt were found to be suffering from a fatal disease due directly to the eating of carrion. Theiler has shown that this depraved appetite is due to the deficiency of phosphorus in the herbage of the veldt, and that the addition of phosphates to the diet immediately abrogates the eating of carrion. More recently, Dr. Orr has shown that the progressive debility of the sheep stock in the Falkland Islands is due to the deficiency of lime in the pasturage there. Again, in New Zealand, there are regions in which an iron deficiency is found, accompanied by the prevalence of certain ailments in the grazing stock.

Generally speaking, scientists are now justified in stating (1) that a deficiency of minerals (whether it be the definite absence of one or more, or whether it be an *unbalanced condition of all*) leads to malnutrition, and (2) that a state of even minor malnutrition is followed by a predisposition to disease, sometimes definitely infectious, sometimes purely functional. Thus a deficiency in *lime* produces sterility; various forms of weakness of limbs and joints; rickets and roughness of coat; a deficiency of *phosphorus* causes stiffness of joints, lack of co-ordination of movements; lack of both lime and phosphorus seems to predispose to tuberculosis; deficiency of *iron* causes anæmia and low vitality of young; and deficiency of *iodine* leads also to loss of vitality, and in human beings to goitre.

To return to the significance of the mineral content of milk. The "ash" composition of cow's milk compares with that of pasture grass as follows* :—

	Calcium.	Phosphorus.	Chlorine.	Sodium.
Ash of Cow's milk	1·7	1·5	1·4	·6
Ash of pasture grass (not hay)				
Good ...	2·6	1·2	3·5	·7
Poor ...	1·5	1·1	2·2	1·1

These facts emphasize two conclusions : (*a*) that good pasture (that is, natural pasture as improved by the skilled agriculturists) is a perfect food for young herbivores—cattle and sheep ; (*b*) even poor (unimproved) pasture approximates in composition to milk.

Finally, Dr. Orr stressed a most significant fact. Under modern conditions, fatting cattle and milch cows are fed on large quantities of plant by-products. Cakes and meals are vegetable substances less nitrogenous and oily matter. These are all, also, more or less deficient in natural minerals ; there is consequently a mineral drain on the animal body, which, in the case of milch cows depletes the store of minerals in the bones. Further, ultimately there is a mineral drain on the soil. Unfortunately, in the present state of knowledge, this drain cannot be definitely corrected, either by direct additions to the soil or by supplementing animal foods by definite "mineral mixtures." Again, it must be borne in mind that this drain is not merely absolute ; it may be relative : the balance of mineral substances may be as important as the absolute amounts, and excess of certain mineral constituents may be as dangerous as deficiency.

In the discussion on Dr. Orr's paper, many facts confirmatory of his views were elicited, of which perhaps the most significant was the observation made by Mr. Hay, of Somerset, that in some cases he had observed that the incidence of tuberculosis in cows could be correlated with a lime deficiency in the soil. It may also be re-

* These figures compare the content of quantities of equal feeding value of

corded that Mr. Boutflour, whose experience of cow rationing is very wide, finds that a mineral addition to cow rations often gives satisfactory results.

In closing the discussion, Sir F. Gowland Hopkins wittily suggested that, as the last man who had taken an interest in a grass diet died so long ago, it was difficult for him, a student of human nutrition, to take an active part in the subject of the Conference ! He thought, however, that what had been said pointed to the importance of a conclusion to which his own researches had long been directed, namely, the supreme importance of small factors causing malnutrition and, ultimately, predisposition to disease.

The Function Of Materials In The Animal Body.

On the afternoon of April 8, Mr. J. B. S. Haldane, Reader in Bio-chemistry, gave a lecture on the function of minerals in the animal body. Of the experiments by which the lecture was illustrated, the most striking was a demonstration of the influence of a solution of mineral substances on the beating of a heart separated from the body of a rabbit. It was shown that a solution approximately of the same composition as sea water maintained pulsation indefinitely, while the omission from the solution of a single ingredient led to a cessation. Another striking demonstration was the action of minerals in relation to the proper functioning of such enzymes as ptyalin, the active principle of saliva. It was shown also that minerals generally are required for the activation of proteins, the free ions of the former determining the physical conditions (solution, etc.) of the latter. Coming to the specific action of inorganic substances generally, it is known that, apart from those present in the bones, they constitute less than one per cent. of the animal body, and of these, calcium, phosphorus, potassium, sodium and magnesium bulk more largely than other necessary constituents such as iron, iodine, zinc and fluorine.

The Composition and Nutritive Value of Young Grass.

On April 9, the forenoon was occupied by an account given by Dr. Woodman of his recent researches on the composition and nutritive value of young grass, that is, grass in a condition before the formation of flowering stems, with its accompaniment of lignification, has set in. Briefly, the methods employed were the cutting of the grass with a lawn mower at weekly intervals, the drying of the produce, its analysis and the carrying out of digestion experiments with sheep. For purposes of comparison, plots were hayed and periodical cuts of the aftermath were taken. The experiments covered the seasons of 1925 and 1926 and were conducted both on light and heavy land. Figures were obtained showing by weekly intervals the total weight of fodder produced, its chemical composition, and the actual digestibility of the several constituents. Dr. Woodman put before the Conference a number of tables of relevant figures, accompanied by remarkably vigorous and lucid explanations and illustrations. The whole was of extreme value, furnishing as it did an example of careful scientific reasoning, surrounded, as all such reasoning must be, by the limitations which the conditions of the experiments necessarily impose. There is no feature more characteristic of modern research work than the essentially provisional nature of all scientific hypotheses, and the care that is taken to avoid the dogmatic certainty which so often characterizes the utterance of the non-scientific man.

The principal conclusions reached by Dr. Woodman may be stated briefly as follows :—

(1) The produce of closely grazed pasture has a higher feeding value than has hitherto been believed : the *dry matter* of young grass (not exceeding 3 to 4 in. high) may be characterized as a concentrated food of high protein content and remarkable digestibility ; it contains, moreover, adequate amounts of vitamins and of minerals such as lime and phosphorus. These characteristics persist during the whole grazing season from April to October.

Thus it was found, in two seasons and on soils of contrasted character, that the *dry matter* of closely mown pastures, in April to June, contained from 21 to 27 per cent. of crude protein, whereas the corresponding figure for hay (cut June 25) was 9 per cent. In July the figure was, for pasture, 21-25, and for aftermath 18-23 per cent., and for weekly aftermath cuts in July-October the figures were 23-29 per cent. of crude protein.

Next as regards digestibility: The protein of pasture showed 77-85 per cent. digestibility, whereas the protein of hay showed only 56 per cent.

Next, the starch equivalents of the produce *per acre* over the whole season may be contrasted: From pasture cuts 2,300 lb., containing 680 lb. digestible protein; and from hay and aftermath cuts 2,450 lb., containing 430 lb. digestible protein. In regard to these figures, it should be noted that although when measured in terms of starch equivalent the produce in each case is much the same, the pasture cuts contain 50 per cent. more digestible protein.

Finally, the digestibility of the dry matter of pasture grass and that of the moisture-free content of an average sample of a feeding-cake may be contrasted.

Digestible Protein Per cent.		*Starch equivalent per cent.*	
Pasture	*Cake*	*Pasture*	*Cake*
22	19-27	74	52-84

Digestibility of Organic Matter per cent.	
Pasture	*Cake*
84	58-80

(2) Under ordinary farming conditions the dry matter of good pasture grass, *whatever its botanical composition*, retains the characteristics of a highly nutritious concentrate all through the grazing season, provided that it is kept closely grazed. Where the pasture is sparse and "poor," close grazing and the use of fertilizers to ensure density of herbage should be able to overcome any difficulty arising from inferior botanical composition.

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This conclusion is justified by the following facts. The botanical composition of the two pastures under experiment differed widely ; nevertheless, the analyses and feeding trials gave much the same results. Further, the botanical composition of each plot changed in the same season under treatment with no sensible effect on the results.

(3) A ration purely of young grass is unbalanced ; it is too rich in protein and too deficient in carbohydrates. It should be supplemented by a carbohydrate concentrate such as a cereal grain.

This conclusion follows from a consideration of the figures given above.

The discussion which followed this paper was confined to a consideration of the bearing of the work on practical farming ; that it will be profound, particularly on existing methods of management of grassland, was agreed by all the speakers. The extension of Mr. Woodman's investigations will be awaited with interest.

Sectional Grazing Plus Nitrogenous Manuring.

On the forenoon of the third day of the Conference (Sir Daniel Hall in the chair,) Mr. W. Brunton gave an account of his trial of the Hohenheim system of sectional grazing coupled with nitrogenous manuring. The system in question was fully described in an article published in the issue of this Journal for September last, p. 498. Briefly it consists in stimulating the continuous growth of herbage by repeated applications of a nitrogenous manure (in this case sulphate of ammonia) and the rapid grazing down of the young produce followed by periods of 20-30 days' rest during which (if necessary) a further application of manure is made. Contrary to what has been taught and believed for a generation, this treatment has no evil effects on the quality of the herbage ; no mat is produced and—an unexpected feature—the growth of wild white clover is stimulated.

Mr. Brunton's experiment related to 27 acres of pasture land, a large part of which was originally of poor quality and set aside for grazing by horses. The whole

area was divided into seven paddocks by means of rough four-wire fences. the two upper wires being barbed. Arrangements were also made whereby a pipe supply of water was available for the stock in each paddock. The trial has occupied two seasons—1925 and 1926. In the autumn of 19 4, the whole area was treated with lime (15 cwt.), superphosphate (5 cwt.), and kainit (4 cwt.), followed by an application of sulphate of ammonia at the rate of 1 cwt. per acre. Further dressings of the last mentioned manure were made during both summers amounting in all in some cases, to 4 cwt. per annum. The total cost of the fencing, manuring, etc., was at the rate of £4 6s. per acre. The results obtained in 1926 on the 27 acres were briefly as follows :—

March 15. Grazing started with 30 ewes and 40 lambs.

April 8. Milch cows replaced sheep.

October 10. Cows removed.

October 23--December 31. 120 lambs at grass.

Total pasture days (stock carried multiplied by days of grazing), 8,555.

Average number of cows pastured 46, or 1·75 per acre.

The procedure was to stock the paddock at the rate of 10-12 cows per acre for 5 days ; then to allow rests of 20-30 days, during each of which, if necessary, as judged by the growth of herbage, a dressing of sulphate of ammonia was given at the rate of 1 cwt. per acre.

Mr. Brunton is of opinion that, provided care and intelligence are exercised, the system is a sound business proposition. It provides a longer grazing period (note the early commencement and the late close) ; gives a great saving in the cost of concentrated food (no less than £164 in this case) ; enables more stock to be carried per acre ; and leads to a great improvement in the amount and character of the herbage.

Mr. Brunton's conclusions were confirmed by the results obtained at Reaseheath Farm Institute, Cheshire, of which some account was given by Mr. Carr, Agricultural Organizer for the County.

The discussion which followed Mr. Brunton's address went to emphasize his view that a requisite of the new system is, above all, intelligent management. A point which requires study is the extent to which the system can be applied to ordinary farming ; it was generally agreed that under ordinary conditions only a fraction of the grassland of a farm can be treated intensively—a considerable area must be kept for hay and rough grazing—and what this proportion should be remains in doubt. It should be noted, too, that so far no experience with fatting stock is available.

As a result of the enterprise of Messrs. Nitram, Mr. Brunton's experiment is being repeated at some 30 centres in the country. It is interesting to note that the remarkable results obtained confirm Dr. Woodman's work on the high feeding value of young grass.

In the afternoon the Conference listened to an interesting address by Mr. J. G. Stewart, in which a great many problems of grass husbandry were discussed. Mr. Stewart stressed the economic importance of providing winter keep, expressing a hope that plant breeders would give more attention to the practicability of either introducing or breeding a variety of grass endowed with the capacity of growing at low temperatures. A description was given of the experiments being conducted at Hohenheim, to which Mr. Stewart made a visit last summer. Among the notable features there was the luxuriant growth of perennial rye grass and white clover, and the fact that, although the treatment had been followed for ten years, no signs of deterioration were visible.

In the discussion which followed, Professor Stapledon made a valuable suggestion based upon what he had seen in New Zealand, namely, that it should be possible to practise sectional grazing without the necessity of providing special fencing. Mr. Carr of Cheshire, gave the result of some observations he had made on the evil effects of small dressings of sulphate of ammonia on grassland. Mr. Bond, of Derbyshire, contributed an interesting speculation on the possible action of nitrogen on a dead mat of grass, in a manner similar to that observed by Hutchinson

and Richards in connexion with the rotting of straw. In closing the discussion, Sir Daniel Hall suggested that the Hohenheim method would best be applied to second-class pasture.

Results of Grasslands Trial Plots.

On the fourth day of the Conference (Mr. R. M. Wilson in the chair) Dr. Hanley, of Bristol University, read a paper summarizing the results obtained on the plots laid down in pursuance of the Ministry's grassland "campaign" initiated in 1919, and giving the deductions he had made as a result of his visits to these experiments. These reached the remarkable total of 700 in all, situated in 50 different counties. Dr. Hanley presented a classification of poor pastures, indicating in each case suitable means of improvement. In regard to these, his experience led him to doubt the value of indicator plants, such as Calluna, as a guide to treatment. The peats often presented an insoluble problem ; downland, on the contrary, was the easiest of all to treat. Broadly speaking in most cases either a complete manure, or phosphates followed by lime, gave the best results, but it was most important in all cases to observe that the full effect of mineral manures is shown under pasture conditions only. It is futile to measure results by taking a crop of hay. Except in the presence of a mat, the use of phosphates was generally successful, high solubility doing better than low. Dr. Hanley was strongly of opinion that further experiments in the use of phosphates in dry conditions, as well as in methods of improved management, were needed, but, on the whole, the grassland campaign had been productive of very useful results.

Grassland Botany.

On the forenoon of April 12, the closing day of the Conference, Professor R. G. Stapledon (Professor Scott Watson in the chair) read a widely ranging paper on grassland problems, considered mainly from a botanical standpoint, and illustrated by an interesting series of graphs, embodying the results of the researches of the Welsh Plant Breeding Station.

At the outset, the lecturer stressed the importance of two considerations : the effect of the nature of the herbrge on stock, and the no less important consideration, the effect of the stock on the herbage. He showed a number of useful seasonal produce graphs of various species, demonstrating that the problem of maintaining a more or less constant supply of produce was dependent on securing some mixture of species. For winter keep, he placed Italian rye-grass in the forefront. Generally speaking, a species had to be considered from many aspects, of which its productiveness, persistence and aggressiveness were the most important. The differences of mineral content should also be observed, coltsfoot, for example, being specially rich in phosphates. All round, the clovers were better mineral carriers than the grasses. Incidentally, the high mineral content of rape was emphasized. Professor Stapledon expressed some doubt as to the ability of certain pastures to withstand such a defoliation as a prolonged period of close grazing might entail. He also stressed the usefulness of temporary leys in providing abundance of keep at seasons when it is most needed.

Perhaps the most striking of the valuable series of figures presented by the lecturer was one correlating the laboratory germination percentage with the actual plant population resulting from the same seed. The figures showed conclusively that there is very little correlation between laboratory figures of germination and the actual proportion of plants finally established, the latter depending largely on variety. Great importance was attached to the proper arrangement of grassland, such as the optimum number of animals grazed and the duration of grazing. Belief was expressed in a system under which grass fields should be used both for hay and pasture in the same season.

In relation to grass mixtures, Professor Stapledon advocated a prescription involving a few species each of a suitable strain specially chosen to suit the particular soil and the particular style of farming pursued.

National Aspects Of Grassland Husbandry.

The last address of the series was given by Professor T. B. Wood (Professor Sir R. H. Biffen in the chair), and was devoted to a consideration of the national aspects of grass husbandry as they were likely to be modified to suit new conditions, such as (1) the progressive increase in the area of grass, and (2) the new knowledge now available. He showed that the bulk of the grassland was now producing a "coarse fodder" suitable for maintenance rather than for production. The new knowledge suggested that much of the existing grassland could be utilized for production purposes. What was needed was simply close grazing coupled with better management in the matters of stocking and manuring. On a consideration of the economics of the problem, it would appear that the head of stock carried under ordinary conditions would not be sufficient to eat down the grass in the flush season, and that, consequently, in view of Woodman's results, the surplus produce should be mown, and, if practicable, used (in a dry state) as a concentrated feeding stuff at seasons when growth was less active. Professor Wood presented calculations which showed that, in grazing inferior pasture, animals consumed a considerable portion of the available energy merely in walking about to find an adequate supply of food. As regards the system of sectional grazing advocated earlier in the Conference, it was suggested that farmers generally would have difficulty in putting up the capital needed.

In conclusion, Professor Wood, summing up the trend of the whole conference, suggested that scientists have now a philosophy of grassland husbandry to offer to practical men. Hitherto grass had been treated almost as a jungle product, which needed no special management and might be left to the mercy of nature. Scientific attention had in the past been concentrated on arable husbandry and comparatively little research had been done in the productivity of grassland. As a result of the converging attack of the botanist, nutrition chemist and physiologist, many new facts had come to light, the summing up of which

should enable the husbandman to make a reasoned attack on what seemed to be likely to become the agricultural problem of the age—how to make the best use of our ever-increasing grasslands. At the close of his address, Professor Wood created great interest by distributing samples of a grass "cake" made under his direction from closely mown grass, subsequently dried in a malt house and then compressed into an adherent mass. Feeding experiments with this cake are about to be instituted with material to be supplied by Messrs. Nitram Ltd.

Finally, some reference to a domestic side of the Conference should be made. The arrangements for the housing of the members were excellent and directed by Mr. P. G. Dallinger, the Ministry's Chief Inspector of Education. He, in his turn, feels that acknowledgments are due to Professor Wood and the Master and Fellows of Gonville and Caius College for the comfort which all attending the Conference enjoyed throughout the meeting.

PREVALENCE OF "ROUP" IN FOWLS AND CHICKENS.

Its Detection And Treatment.

By Samuel Bruce, M.V.D.
Acting Government Veterinary Surgeon.

The mention of the term "Roup" usually brings to mind the complex diseased group variously known as chicken-pox, canker or diphtheria, etc. More recently it has been associated with disturbance in nutrition and as a result there exists some confusion as to the significance of the term. Perhaps if we adopt the view that many of the more extensive searchers into poultry disease now hold we will simplify matters. Let us apply "Roup" to describe a

condition manifested as a "cold in the head" or a catarrhal rhinitis. At any rate confine it to the upper air passages and adjacent sinuses. As such it may be primary or secondary. Thus it may arise from cold, and infection of a non-specific nature just as in other species.

Predisposing factors are overcrowding, poor ventilation and climatic conditions.

Secondarily, we may expect it to be associated with a number of ailments, more particularly fowl-diphtheria, pneumonia, fowl-cholera, and disturbance in nutrition. We have an analogous situation in the horse with influenza and glanders, in the dog with distemper and in the hog with cholera.

In other words, roup is a symptom just as rhinitis (cold in head) often is and not a clinical entity in every case.

It is characterized by a sticky discharge from the nostrils which dries and plugs up the openings, thus causing the latter formed discharge to back up and penetrate the nasal openings. There it accumulates, dries and becomes cheesy in nature (a common thing in birds is for pus to become cheesy or caseous), causing bulging below the eyes and even evolvement of the same. All cases may not go to this extreme but attention is here called to this possibility to show how exactly we may be misled into calling all such cases canker or fowl-diphtheria and considering them to be due to a specific infection. The condition may be complicated with pneumonia and terminate fatally. There is usually a falling off or suspension of egg production, loss of appetite and ruffled feathers. It may be difficult in many cases, to differentiate this condition from canker, but we will try to limit the application of the term to the more benign disease of the nose and adjacent sinuses. Should symptoms such as described above have associated with them pox, lesions on the comb and wattle, we would then unhesitatingly rule out the diagnosis of simple roup. Young chicks fed from the time of hatching or shortly thereafter on a ration lacking in vitamines, such as a ration

of corn, bran etc., will, in from two to six weeks show symptoms of "leg weakness," loss of appetite, anœmic condition of the comb and wattles, drooping wings, ruffled feathers and frequently inflammation of the eyes. At first there is a thin viscid discharge which may glue the eyelids together, then the formation of a tightly, adherent, white membranous film, and finally the collection in the conjunctival sac of white, cheesy exudate. This eye affection is the most characteristic symptom of the deficiency disease and because of the resemblance to the formerly so called "roup," it is best diagnosed by necropsy. Birds affected shows a severe involvement of the kidney. This organ appears pale and marked with the network of very fine white lines, which are tubules filled with urates. The ureters become as large as a lead pencil. These white deposits of urates are found on the liver, heart and other organs. Pustule-like lesions, of the size of a pin-head, are found on the mucous membrane of the mouth, pharynx and aesophagus very much as we find in canker (fowl-diphtheria). Also we occasionally find white cheesy material in the cleft and mouth. In fowl diphtheria the caseous material is yellow in colour.

Treatmemt—For simple roup (cold in the head) swab out nostrils and cleft, with a pledget of cotton, then immerse the head in a warm one and a half per cent. solution of creolin, or any coal tar product for a few seconds. If one wants to take a little more pains, insert this solution or a few drops of tincture of iodine through the nostrils with an eye dropper or syringe, holding the mouth open to allow the fluid to escape. This should be done twice daily until discharge ceases, Make an incision into the bulging sinuses and squeeze out the mass, then treat antiseptically; preventive measures will naturally suggest themselves when we consider the cause.

Avoid draughts, exposure, etc: correct improper housing conditions. As a precautionary measure all sick birds should be isolated. There are no biological agents of any value in this condition. Nutritional roup may be readily cured if not too far advanced by the administering of cod

liver oil and allowing access to plenty of green food. The latter measure will usually prevent the appearance of the disease. Roup associated with fowl diphtheria (canker) is a formidable proposition. Isolation is imperative.

Badly infected birds are best dealt with by destroying. Mildly affected cases can be handled as suggested under simple roup. Direct attention to preventive measures. Ventilation has been tried abroad with conflicting results.

EXPERIMENTS IN ROTARY TILLAGE.

EXPERIMENTS into the principles of rotary tillage have up to date been fruitful more in suggestions for further research rather than in convincing evidence vindicating the method. We say this in no disparagement of rotary tillage but more with the object of showing the need there is for the subject to be studied *au fond.* That this need should exist to-day is passing strange, since rotary tillage has been with us for several years now and many agricultural authorities, scientists, soil physicists and others are fairly well agreed that this form of cultivation will some day supersede the plough. But what is hindering the supersession at this juncture ? If rotary tillage is so much more to be preferred, if it presents the ultimate criterion by which all cultivation methods will be judged, if it is so advantageous from a labour-saving standpoint, why does it not make greater headway with farmers to-day ? That is a most pertinent point. Admittedly prejudice has an arresting effect on so novel a way of performing many operations with the minimum of effort and time, but prejudice can be swept away by educational investigation. That is why it is urgently necessary for some authority to undertake a complete inquiry into the position. We were assured last year that a certain institution was to conduct such an investigation, but pressure of other work and more

important duties have apparently caused that plan to miscarry. Meanwhile the main problems remain unsolved. Inquiries of a type are made here and there. We referred to one in the last issue of THE REVIEW, but the author of that examination was the first to describe it, in effect, as somewhat inconclusive. We have details of another inquiry which has been made in Vienna. In this case the rotary cultivation gave by far the richer crops compared with the controlled plot, but the test contains the fundamental weakness, to our mind, that the whole area, control and experimental, was first ploughed. This certainly vitiates the comparison between a method which is held to supersede the plough and companion tillage implements, and the older method now so generally practised. For this reason it would be unwise to dwell on the actual crop contrasts since the comparison is not a true one of two distinct forms of cultivation. Attention can be drawn, however, to one really remarkable circumstance, and this despite the fact that both areas were first ploughed. It was found that the proportion of beet to leaves on the experimental plot—for the crop grown was sugar-beet—was very dissimilar from that on the plot ploughed, cultivated and harrowed in the usual way. In other words, it was discovered that rotary tillage shifted the relation between beet and leaves very much in favour of the former, a phenomenon characteristic of air nourishment in distinction to soil nourishment, and from this it is deduced that rotary tillage, with its intensive and uniform loosening of the soil, brings about a more rapid decomposition of the humus present in the soil and perhaps of stable manure supplied than does ploughing. This question, it appears, is to be the subject of further investigation, which merely goes to confirm the timeliness of the plea we put forward for a complete and satisfying inquiry into the entire matter, particularly as it is commented in this instance also that the claim that rotary tillage does a series of operations simultaneously and effectively presents a field for much study, especially when different classes of soil are taken into account.—*The Implement and Machinery Review, Vol. 53, No. 626.*

ERRORS IN FEEDING LIVE STOCK.

By T. B. Wood, C.B.E., M.A., F.R.S., Professor of Agriculture, Cambridge University.

During the past 25 years, hundreds if not thousands, of papers have been published, many of them containing facts and observations each of which has added a little to the sum of our knowledge of the laws of nutrition of farm animals. It would, I suppose, be within the bounds of possibility to give a detailed catalogue of these individual papers, setting out the salient points of each. Such a proceeding would take a very considerable time, and would be quite useless to the farmer, although valuable to the investigator. Indeed, every investigator before he starts his investigation makes such a catalogue in his special line of work, either on paper or in his own mind, in order that he may experiment in the light of other people's results.

I myself have read many of the papers on nutrition published during the last 25 years, and what I propose to set out is the general impression of the practical value of nutrition research which their perusal has left on my mind. It will of necessity be a personal impression—another writer might stress different points—but I hope it will be useful to the practical man, as it has been to me, not only in the conduct of my own research work but in the rationing of the animals on my own farm.

Traditional Methods are Wrong.

My first impression, and I do not think this particular point is open to argument, is that the great majority of owners of live stock who feed their animals on traditional lines, are wrong in the following particulars :—

(1) They include too much protein in the rations of their fattening animals.

(2) They include too much protein in the ration of their working animals.

(3) They do not give enough protein to their young growing animals.
(4) They do not give enough protein to their milking animals.
(5) They do not give enough ash constituents of the right kind to their growing animals and their milking animals.

Points 4 and 5 are, however, not within the province of this article. They have been dealt with already by Mr. Mackintosh, of Reading, Dr. Orr, of Aberdeen, and Dr. Crowther, of Harper Adams College; consequeutly, I do not propose to discuss them further. The remainder of this article will be devoted to discussing points 1, 2 and 3.

Protein For Fattening Animals.

The usual method of feeding fattening animals, namely, to give them roots and straw or hay, supplemented by a generous ration of oilseed cakes, has been handed down traditionally from the time when it was started at the close of days of the great landlords 70 or 80 years ago. It originated from the work of the first chemists who turned their attention to agriculture, and concluded, on grounds which have subsequently been found to be wrong, that fat could only be produced in the animal body from fat or oil and protein. Oilseed cakes, being rich in both these constiutents, seemed excellent for fattening, their use became general, and the custom has lasted.

It is about 70 years since Lawes and Gilbert showed that most of the fat formed in the body of a fattening animal was formed from carbohydrates, such as starch and sugar; but this observation, although accepted by physiologists, is only just beginning to find its way into agricultural practice as the result of more recent research.

Recent accurate research on this subject dates from Kellner's measurements of the fat-producing power of proteins, oils and carbohydrates, which showed that proteins were distincty less effective fat-producers than either of the other recognised constitutents of feeding stuffs. Still more recent work has shown that full grown animals

required much smaller amounts of protein than most rations provide, and that increased supplies of protein in the case of such animals do not raise the rate of live-weight increase.

The amount of digestible protein required by full-grown animals on full fattening rations is well known. It is, for a full-grown or approximately full-grown steer, not more than 1½ lb. of digestible protein per day; for a full-grown sheep not more than 1¾ lb. of digestible protein per week. These quantities are usually greatly exceeded. The excess does no harm to cattle, except, of course, that its provision entails wasteful expense. In the case of sheep, an excessive supply of protein is apt to cause death through failure of the kidneys.

Protein for Woking Animals.

As with fattening stock, so with working animals, the traditional idea is that protein is the source of muscular energy. This is not true, and there is no need to increase the protein in the ration of an animal because it is required to do hard work. It is unfortunate, however, that no important additions to our knowledge of the protein requirements of the horse have been made in recent years.

Protein for Young Animals.

It is desirable that a young animal should grow, and consequently that it should increase in weight. The food requirements of the growing animal are to a very large extent governed by this fact, since they must not only keep the animal alive but must provide the material of which the increased weight is composed. In recent years much work has been done on this subject, the gist of which is that the increase in live weight made by a young animal consists mainly of water, but contains considerable quantities of protein and ash. It is noteworthy that a young, rapidly growing animal usually puts on very little fat.

Protein being the most abundant constitutent of the live weight increase of young animals (of course excepting water), it follows that a young animal requires a liberal

supply of protein in its ration. Traditional practice does not give this, especially in the case of cattle. As a rule, young stock are wintered on poor pasture with perhaps a little poor hay or in yards on poor hay or even straw and a few roots. They would do very much better and so would their owner, if they got some of the cake which is so often wasted on fattening cattle and sheep. This fact is beginning to meet with some measure of recognition, especially in the production of "baby" beef fat lambs and pigs which are ready for the factory at six or seven months old.

Computing Rations.

My next point is that the knowledge which has accumulated as the result of the research work carried out during the last 25 years makes it possible to compute a ration which will produce any desired result within the posibility of the animal which is to consume it.

For some time past, advanced milk producers have adopted the method of basing their rations on the principle of maintenance ration *plus* an additional allowance per gallon of milk. In much the same way it is possible to compute rations for young growing animals or for fattening animals on the basis of maintenance ration *plus* an addition for each pound of live weight increase which it is desired to produce.

. The essential points of rationing on this system are :—(1) That an animal's appetite is limited—a full-grown steer, for instance, will not eat more than about 25 to 30 ℔. of food per day, weight in the dry state.(2) That a large part of this food is required simply to keep it alive—this is the maintenance ration—and its amount, measured by modern experiments, is given in the books referred to above. To this maintenance ration must be added so much real nutritive value per ℔. of increase expected.

The more increase one expects, the more real nutritive value it is necessaay to get into the limit of the animal's appetite ; which means using highly digestible foods such as cakes, corn, meals and roots for the productive part of the ration. For young growing animals

requiring much protein, a good proportion of cake is desirable. For adult fattening animals, corn, meal, and roots are cheaper and more suitable.

Starch Equivalent.

It is usual to measure the real nutritive value of feeding stuffs in terms of their starch equivalent as determined by the method of Kellner. The weight of starch equivalent required to produce 1 lb. of increase in animals of various classes has been found from the results of research modern on the composition of the carcases of animals. This method of computing rations is a distinct advance on the methods hitherto in use. When it gets absorbed into the general practice of farming it will correct the common errors in feeding noted above, and will add materially to economy in animal production.—*The. Farmer and Stock-breeder and Agricultural Gazette No 1889.*

THE ROOTS OF SUGAR-CANES.

Their Distribution in Soil.

In the new American Journal, *Plant Physiology* (Vol I. No. 4.) Dr. Atherton Lee publishes a very interesting account of his work on the distribution of sugar-cane roots in the soil.

The method used is ingenious yet simple, and gives results which are quantitative. It consists in collecting and weighing roots present in consecutive soil strata, each of thickness eight inches. Five representative stools of cane are selected and the stems cut down level with the surface of the soil. Stakes and boards are erected so as to enclose the area occupied by the plants. Excavations are then commenced within the rectangular space. The soil of the first eight inches is removed by a spade, and thrown on to a one-quarter-inch-mesh sieve. Care is taken to cut

the soil as close to the stools as possible, so that it contains all the roots that occupy the first eight inches depth of soil. The roots are then separated by screening through the sieve, washed, dried and weighed. The next eight-inch layer of the soil and roots is similarly excavated, and its root content determined by screening and weighing. The process is repeated for each eight-inch stratum down to the forty inches level. By these means precise numerical *data* are recorded.

Conclusions.

1. The majority of the roots of sugar-cane grown in Hawaiian soils under Hawaiian conditions, occur in the uppermost levels of the soil. In the case of canes grown *in furrows*, more than 58 per cent. of the roots occur above the 8-inch level. In the case of canes grown *on ridges* (hilled-up canes), the largest proportion of roots occur between the 8-inch and the 16-inch levels, measured from the base of the stool, In either case, only 15 per cent. or less of the roots occur below the 24-inch level.

2. Irrigation water will reach more roots in the case of canes grown in furrows than in the case of canes grown on ridges.

3. Cane varieties liable to root disease, or canes grown without irrigation, will obtain more root aeration if grown on ridges than if grown in furrows. The roots of canes suffering from lack of aeration seem to exhibit a black colour due to the absence of numerous secondary feeding roots, and to the rotting of the cortex tissue, which leaves the stele uncovered. On the other hand, healthy, aerated roots exhibit a light-brown colour, are well supplied with feeding roots, and possess intact cortex tissue.

4. Deep tillage preparatory to planting, and the incorporation of organic matter into the deeper soil strata should encourage aeration, should stimulate the formation of secondary feeding-roots, and should minimize root-rots.

5. Calculations from weights recorded in these studies indicate that between 0·9 and 1·85 ton of dry organic matter is left as cane-rooots in the soil by a crop of some 8,500 stools of cane per acre, grown under irrigation in Hawaii.

VISIT OF KEW BOTANIST.

Mr. H. C. Sampson, C.I.E., Economic Botanist at present attached to the scientific staff at Kew, England, where he is engaged mainly on investigations connected with the disposal and marketing of tropical agricultural products, arrived in the Colony on July 31. Since then he has been busily engaged in visiting the various agricultural centres, comprising trips to the North Western District, Pomeroon, Essequibo, Berbice, Corentyne, and other points of interest including several sugar estates. He has also been in touch with some of the commercial houses in Georgetown who handle agricultural produce.

In consultation with His Excellency the Governor who has, from the beginning, taken very great interest in the matter, the Director of Science and Agriculture has arranged Mr. Sampson's programme and is accompanying him on excursions as often as his administrative duties will permit.

His wide experience of agricultural conditions in India and Africa makes Mr. Sampson a particularly valuable officer at Kew when matters relating to agricultural policies in the tropics come up for consideration. Kew has been helpful in the past to the Carribean Colonies in the introduction of useful plants and in other ways ; the policy of sending a qualified officer to gather first-hand information on conditions is striking evidence of the new progressive policy recently inaugurated in connection with agricultural development in the Colonies.

British Guiana is grateful for this visit, made possible through the Empire Marketing Board which is making a contribution to Kew for the maintenance of this and similar services involving visits periodically to outlying parts of the Empire.

J. S. D.

FOREST DESTRUCTION AND ITS EFFECTS.

THE question of the action of forests on rainfall has been debated by foresters, agriculturists, engineers, and others for a long period, the discussion probably dating back to the time at which scientific forest conservancy was first introduced. In the tropical and sub-tropical parts of the world this is not, however, the point of primary importance. The vital factor for the community at large is the determination of how far the destruction of forests in catchment areas and on the sides of hills and mountains in the drier parts of a country, affects in the first place, the level of the water in the big rivers, a matter of extreme importance when the rivers are utilised for irrigation or power works ; secondly, the decrease in the local water-supplies and in local precipitations upon which the cultivator is dependent, and, thirdly, erosion and avalanches, and the destruction they cause in the fertile valleys beneath, Sudden floods may also cause enormous damage to railways, towns, and so forth. In India, which was the first part of the British Empire to give consideration to this aspect of the forest question, the matter has been the subject of discussion and reports through the whole of the past century, a statement which will perhaps come as a surprise to many in Great Britain.

The problem of affording protection to forests for the above causes alone is by no means new. In France and Germany special laws for the protection and extension of the forests and the protection of agricultural lands by means of the forest have long been in operation ; and similar laws exist in the Italian States. So far back as 1475, the subject attracted the attention of the famous Venetian Council of X., by whom a law was passed on January 7 of that year, regulating in great detail the clearance of the forests *terra firma*. The mountain forests especially were protected by judicious regulations, which were renewed from time to time down to the very year of the extinction of the old republics. Tuscany and the Pontificial Governments were equally provident.

History has since shown that the wholesale destruction of forests in Spain, Italy, Sicily, Greece, and Macedonia has resulted in a great deterioration of climate over considerable tracts, due to loss of moisture, the sterilisation of the soil, and excessive erosion. Although now well known, the chief action of the forest may be stated briefly as follows: The great factor in mountainous and hilly country is the maintenance of tree growth on parts of the area. In the case of bare slopes the rain rushes rapidly down, causing erosion, only a fraction percolating into the soil, and is carried rapidly away, giving rise to spates and perhaps to serious floods since the old channels of these streams or rivers are no longer able to carry the excess water of flood levels. A hot sun bursting out on to the slope after the rain quickly dries up the thin layer of moisture covering it. In the hotter parts of the globe subject to heavy rainstorms or monsoons, the rushing water starts gullies which eventually become ravines, all surface soil is rapidly washed away, and in the course of years the hillside is eaten into, rubble and boulders being sent down to cover up valuable lands below. When the area is under trees, a portion of the rain, falling on the crowns, drips slowly, down on to the layer of humus beneath and sinks into it. The larger portion perhaps, falls direct on to the forest floor, where it is gradually absorbed in the soft covering which takes it up as a sponge. The water then percolates slowly downwards, filling up springs and underground reservoirs, and reaches the streams in a retarded manner. The flow in the latter is consequently more even and regulated as also the amount of water which eventually reaches the rivers. The latter can therefore be more depended upon to maintain a normal level when it ts required to utilise them for irrigation or power works. The roots of trees protect the surface by holding up the soil, and thus directly prevent denudation.

It is possible to give some concrete examples of the effects of the destruction of teak forests in India during the first half of last century, owing to the large demands for this timber from rapidly expanding markets.

The slopes on the west coast of the Bombay Presidency were once, even in the early days of British occupation, covered with magnificent, valuable, and extensive, teak forests. These have long since been cut out, some disappearing for good. The denudation of the Deccan Highlands and the Eastern Ghats has resulted in excessive erosion and the gradual silting up of the rivers. When the Dutch, French, and English first built settlements on the Coromandel Coast, it was possible to take ships up the Godaveri and Kistna. The English port of Narasapur and the French one of Yunaon, both on the Godaveri, were once the chief ports on this coast. They can now be reached only at high tide by small native shallow-draught craft. Last year the present writer had arranged to go down the Godaveri from Sironcha, on the frontier of South Chanada (Central Provinces) and the Hyderabad State, to Rajamundri, as he wished to carry out investigations in connexion with the effects of forest denudation on this river. It was early in March, the commencement of the hot weather season only. Inquiries elicited the fact that few rafts were now going down, owing to the extensive sandbanks already drying off in the river, and that even by dugout canoes, delays from stranding on sandbanks would be inevitable. Some hundred years ago this great river was the chief artery or high road into the interior. At Masulipatam, Dutch ships used to ride at anchor close up to the port, whereas at the present day even small native vessels have to anchor five miles out in the roads owing to the silting up. Between 1840 and 1850, Dr. Gibson, the first Conservator of Forests in Bombay, drew up a list of the rivers and creeks on the Malabar coast, where on arrival in those parts ships used to ride at anchor, all the creeks having silted up within the memory of men then alive.

Dr. Cleghorn, who afterwards became the first Conservator of Forests in Madras, directed attention to the destruction of tropical forests at the meeting of the British Association in Edinburgh in 1850. A committee was appointed to consider this matter. Dr. Cleghorn submitted its report, which was confined to India, the only country for which information was available, at the meeting of the

Association at Ipswich the following year. The report summarised the position, as then known to the few in India who had given attention to the matter, pointing to the great and uncontrolled destruction which was taking place, both at the hands of timber merchants and owing to the careless habits of the native populations, who grazed their cattle at will in the forests and fired them every year in order to encourage the growth of new grass. The indigenous tribes in the hilly country also practised unchecked shifting cultivation, a practice second only to the lumberer in the destruction of fine forests. Under this method, which was a common habit in Europe in olden times, a patch of good forest is felled and the material burnt *in situ* ; coarse grains are then sown on the clearing. The cultivator then sits down and awaits the harvest. Two or three crops are taken off the area ; the weeds then become too strong (as he never troubles to weed) and he moves on to a fresh area. The enormous destruction of virgin forest this practice entails, when practised for centuries, has to be seen to be credited. Yet many of the tropical and sub-tropical forests in British Colonies and Dependencies are still subject to this the most pernicious and precarious form of so-called agriculture (as also to over-grazing and firing), the administrations responsible not having yet, appearently, understood the evils which attend it. The difficulties facing these Governments in prohibiting the practice or controlling it were all experienced in India, in one form or another, and overcome. The encouragement given to the growth of tea and coffee and similar crops by British administrations in the Empire, whilst eminently praiseworthy if carried out on well-considered lines, has been productive of great harm in the past, and even the present day can scarcely be said to be free from anxiety on this score. In a report written in India in 1876 with reference to coffee planting, the following criticism is made :

"The planters who come over from Ceylon are now giving a very high price for land, and the whole mischief may be effected in a very short time. It must not be supposed that coffee is at all a permanent cultivation ; we have only to look at the Sampajee Ghat in Coorg, the Sispara

LAND SETTLEMENT.

The following important communication was made to members of the Jamaica Agricultural Loan Societies Board by Mr. Archibald Spooner, a member of that Board, and also a member of the Board of Management of the Jamaica Agriculture Society.—Editor.

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One of the important points in this connection is that the Agricultural Loan Societies Board has got the organisation to deal with the question of land settlement through the agency of loan banks, and acts for the Government in this matter, whilst no other Government Department has any special organisation for this purpose.

The Banks are formed by the people, owned by the people, and run by the people. If they succeed, the people benefit; if they fail both the people and the Government are the losers. As far as I know, no serious criticism has ever been levelled against the system of land settlement associated with loan banks, and as far as the government is concerned it has, as security for money that it advances, the whole of the assets of the banks. If land be available for land settlement and the people want it, all they have to do is to incorporate themselves into an association called a Loan Bank, and agree to purchase so many shares in this Bank. Upon such agreement if the scheme looks a good one to the Agricultural Loan Societies Board, the Government can lend two-thirds of the face value of the shares agreed to be purchased, which sum will largely form the working capital of the Bank. The Bank can then apply for more money to purchase land for land settlement, and if the scheme is approved by the Government, the Legislative Council can be asked to vote this, and then the land will be in the hands of the people for such sub-division as they may decide upon, and to be sold out at such prices as they may decide upon. They will be left alone to manage their own affairs without interference from anyone so long as the interest of the Government is fully respected and not jeopardised, and every assistance

will be given so far without any charge, by the trained officers of the Agricultural Loan Societies Board, so as to make the whole thing a success. If in spite of such assistance the people, or their officers chosen by them, show inability to manage their affairs, thereby jeopardising their own, and the Government's money, then the Agricultural Societies Loan Board can and does, appoint a capable manager to set the concern on its legs again, after which it will be handed back to the people. If the scheme appears to be a hopeless failure, the Agricultural Loan Societies Board has power to appoint a liquidator who can recover as much as can be recovered of the debts due to the Government.

The system, on the whole has proved a success, and been a powerful agent for the education, uplift and improvement of the people, bringing to the fore talented men like the late Hon. and Rev. A. A. Barclay and others, and entrusting the people with responsibility to each other, and to the Government Land settlement without financial assistance from a land bank would almost inevitably mean that the settlers would have to borrow from money-lenders at impossible rates of interest. The Banks may, perhaps, charge what may seem high rates of interest on certain loans, but these are ever so much lower than those of the independent money-lender ; however, whatever rates may be charged by a Bank, these rates are settled by the officers of the bank chosen by the people, perhaps they could be lowered, if the people as a whole had a higher moral sense in meeting their financial obligations. However, the banks do not pay extravagant dividends ; if I remember right a higher dividend than 10 per cent. is not allowed except by permission of the Agricultural Societies Loan Board and this would be on the paid-up share capital only.

Where mistakes have been made in the past they have been due to buying land at inflated prices or too large an acreage of land, in excess of the requirements of the people of the district, or land not very favourable for the profitable production of crops, or land that has become attacked with Panama Disease. The last land settlement scheme, Daly Grove, in Manchester, has been safeguarded by requiring the bank formed in connection with the scheme,

to pay down a proportion of the land purchase money, the Government finding the rest, and this has been done in a district as hard to make a living in, as any part of the island. In another district, and not a rich one, Stewart Town, a Land Bank has bought an estate for settlement and settled for it without any assistance from the Government.

Personally, I am against land being acquired by the Government and plotted out amongst the people, and the matter ending there unless, of course, the people buy and pay for the land at once. If not, the people would be sure to fall into the hands of money-lenders to whom they *could not even give a first lien on the land and the Government* might find itself forced to resume possession of small pieces of land, perhaps indefinitely for default in purchase instalments. A Loan Bank has the machinery for dealing with this kind of thing, the Government has not.

It would be a different matter if there were a State Agricultural Bank having local branches capable of dealing with matters of local agricultural finance, and the purchase and sale of land for settlement in various parts of the island. Unless this comes, I think we should make the best of the Loan Banks and run the Land Settlement schemes in connection with them and so raise up a self-reliant and self-helping people not dependent on the Government to do for them what they can do ever so much better for themselves.—*Journal of the Jamaica Agricultural Society Vol. XXXI. No. 7.*

THE CELOTEX INDUSTRY

It is reported that the Celotex Company will, within the next two years invest four and a half million dollars more in its Marrero plant, across the river from New Orleans and will concentrate its manufacturing of Celotex in Louisiana, so far as the western Hemisphere is concerned. This will bring the total investment in the plant up to $10,000,000. This improvement will consist of the installation of four additional machines at intervals of six months which will result in the doubling of the present mill capacity. Additional baling plants will also be installed throughout the sugar belt far securing the bagasse, where there are already twenty six balers in operation. It is stated that the Celotex Company already consumes 75 per cent. of the bagasse manufactured in Louisiana. This development is an interesting one, especially to anyone who remembers back to the time when the bagasse was taken from the Louisiana factories and dumped into the river to get rid of it, or, on those places not located on the river, taken to specially built furnaces where it was burned, not as fuel, but simply to destroy it. Then came the day when bagasse furnished a large part of the fuel on the sugar plantations with the improved furnaces that provided for burning the moist material, and now comes its abandonment as a fuel and its manufacture into a building board that has the reputation of being an excellent insulating board and is in great demand.

Mr. H. B. Strait, Australian representative of the Celotex Company of America, has just been in Queensland in connection with the industry. It is claimed that there is enough sugar cane in North Queensland to manufacture 600 million square feet of Celotex a year. A mill is to be established in the center of the country of the north, for which capital has been subscribed. Mr. Strait expresses himself as very pleased with his reception in Australia. His present misson is to create a demand for Celotex. It is being placed on the market and is being used in the town

hall in Brisbane, now being erected at a cost of $4,500,000. Mr. Strait mentioned the progress of the industry in America, where five years ago, 12 million feet were manufactured, whereas last year the total was 200 millions, and this year it will be 350 millions.

There is no doubt that if the industry is successful it will solve many of the building problems of the tropics in Australia, where galvanized iron is most used at present owing to its easy working. Iron is, however, very unsuitable for a hot climate, and makes the lot of women in particular very trying. The authorities on life in the tropics have been urging the use of other material than iron for dwellings.—*The Planter and Sugar Manufacturer*

SUGAR INDUSTRY OF PORTO RICO.

The following is abstracted from an address delivered by Mr. G. A. Jones at a General Meeting of the Trinidad Agricultural Society on June 9th, 1927. Mr. Jones visited Porto Rico last year at the same time as Mr. Wm. Nowell, whom he accompanied over the Island. It is felt that his remarks will be of interest to our sugar planters.—Editor.

The sugar industry of Porto Rico has gone up by leaps and bounds during the last 25 years; from 150,000 tons to 650,000 tons. This increased tonnage coincides with the period of occupation by the U.S. of America and is due entirely to this cause. The three largest factories, producing between them one-third of the Island's sugar output are American owned and controlled.

Porto Rico grown sugar is admitted free of duty to the United States, an advantage of $36 per ton. It was generally agreed that without this preference Porto Rico would not be able to produce sugar in competition with Cuba and other countries.

A commission of investigation recently appointed by the Governor of Porto Rico reports the cost of production in competitive countries in 1922 as follows :

Cuba................	2.14c. per lb.
Hawaii..............	4.01c. per lb.
Porto Rico.........	4.04c. per lb.
Louisiana...........	4.85c. per lb.
Beet Sugar (U.S.)	5.02c. per lb.

The enormous preference that Porto Rico thus enjoys has brought prosperity to her sugar industry and has stimulated the adoption of better Agricultural methods.

An enormous amount of capital has been expended on immigration projects both public and private. This is particularly so in the South of the island where the largest Centrals are situated. (Guanica 100,000 tons, Aguirre 60,000 tons, Mercedita 23,000 tons). The rainfall in this section of the island is very low, about 20 ins. per annum, they are therefore almost entirely dependent on irrigation. One scheme laid down in 1908 cost the Government $5,000,000 and irrigates 333,000 acres, another more recent one irrigates 12,000 acres at a cost of $3,200,000.

The tax for public irrigation is $15 per acre per annum—a reasonable insurance against drought.

Hydroelectric power is often developed in connection with irrigation systems.

The conditions on these irrigated estates are so different from ours in Trinidad that little will be gained by comparisons. The soils are rich, deep, black alluvials.

In the Northern district the soils are not so fertile as those of the South Coast Estates, and they do not depend to the same extent on irrigation, but some irrigation is practised on most of these estates to supplement the rainfall. Here again the soils are mainly deep alluvial.

It is in the North-Eastern section of Porto Rico—in the Fajardo district that we found conditions approximating those of the Naparimas. Several of the Fajardo Estates are undulating and at least one could be termed hilly. The Fajardo soils are termed 'heavy' but we saw nothing

approaching our heavy soils anywhere in Porto Rico. This important factor must be continually borne in mind when comparing conditions and practices in Porto Rico and Trinidad respectively.

CULTIVATION PRIOR TO PLANTING.—

The most thorough preparation is given the soil before planting. The general practice is to plough the lands with a Fowler outfit of which one or more sets may be found on all estates of any size. After a fallowing period of one or two months the land is cross-ploughed two or even three times with a harrowing in between. The second and subsequent ploughing is usually done with ploughs drawn by "Fordson," "Oil Pull" or "Holt" tractors and very frequently by cattle drawn ploughs.

This thorough cultivation is in strong contrast with our cruder methods of drilling, etc., but the difference is largely due to varying soil conditions. During our visit in September, one of the wet months, all these ploughs ranging from a Fowler outfit to cattle ploughs, were at work practically every day, and within a day or two of a fall of one or two inches of rain the soil was quite workable.

However, the point is that if these soils require so much working up, then our much heavier ones require more. When we give one ploughing we regard it as something of a luxury, whereas these soils are being constantly turned up.

DRAINAGE AND FORMATION OF BEDS.

The question of drainage and formation of beds is tackled in a totally different manner in Porto Rico as compared with Trinidad and is one of the first things that attracts attention. Instead of having deep drains every 20, 25 or 30 feet, their fields consist of a series of 9 or 10 feet wide ridges, each ridge having two rows of cane. On either side of the two rows of cane a shallow drain, sometimes made entirely with a double mould-board plough, and in heavier soils finished with a spade leads to a cross-drain dug a little deeper and situated every 40, 50 or 100 feet, apart, the distance of these depending on the nature of the soil.

This practice is almost universal throughout the non-irrigated sections of Porto Rico. In this way they do away with the necessity for deep drains and subsequent ploughing and cultivation is made very much easier.

Whether this system would work with our soils is a matter for experiment but it is well worth a trial.

The ridging and the draining is usually done with cattle-drawn ploughs and in making the ridges, two cuts are first made with the single mould-board plough, one each way, before the mould-board plough is used. This lightens the final work of ridging considerably.

It might be conveniently mentioned here that cattle-ploughing has been developed into quite a fine art in Porto Rico. Every native handles a plough most skilfully and on the steepest lands. The most popular hill-side-plough for cattle ploughing is one made by the Weird Plow Company, and is a one way plough.

The best ploughing I have ever seen in the West Indies was at Aguirre, where men were ridging with a cattle-drawn double mould-board plough, following the contour of a slightly rising ground most perfectly.

Cane Seed and Planting Distance.

I find the general tendency is to plant more and more seed per acre. Mr. McConny, the Field Superintendent of Fajardo—a most successful planter—though brought up in the Barbados School of wide spacing is an absolute convert to the "ample seed" doctrine.

The usual practice on good lands even in irrigated districts is to space the rows 4½ ft. apart and on poor hill-sides the planting distance was 4 feet.

When cane holes are made—a practice that is now dying out—three and four plants are put to the hole. When the planting is done in furrows we found several methods in vogue: (a) a continuous planting with long

cane covering the seed with a hoe or sometimes with a plough; (b) continuous planting with a row and half thus:—

(c) double plants one foot apart as at Mercedita :—

1ft.

The aim is to have a good stand of cane from the outset and to cut out supplying as much as possible. By this method it is also claimed that far more cane of a uniform, mature age is obtained as they have not to depend so much on suckering latter on. Furthermore the land covers in very much quicker reducing weeding and soil washing.

There is evidently room for experimenting in this direction. One of the obvious objections is the far greater amount of seed required per acre, but in Porto Rico they think nothing of using 3—4 tons of seed per acre provided they get a good spring which they regard as all important.

Pen Manuring and Fertilizers.

One of the most remarkable things we met with was the complete absence of pen manuring as an agricultural practice in Porto Rico. On no estate visited was this practised. There is s complete absence of pens and the animals are all grazed in the pastures and the manure lost. They maintain that the operation is too costly under Porto Rican conditions of expensive labour. The remarkable thing is that they are able to carry on without it and get highly satisfactory yields per acre as the following will show.—

Estates I.—Irrigated, Crop 1925.

Wet season plants 60 tons per acre.

Crop Plants—40 tons per acre.

1st Ratoons—32 tons per acre.

Estate II.—Non-irrigated, Crop 1926.

Area as wet season plants, 1,580 acres yielded 41.8 tons per acre.

Crop Plants 632 acres, yielded 36.1 tons per acre.

1st Ratoons, 2,250 acres, yielded 26.7 tons per acre.

2nd Ratoons, 2,499 acres yielded 41.8 tons per acre.

3rd Ratoons, 791 acres, yielded 20.0 tons per acre.

Other Ratoons, 249 acres, yielded 21.04 tons per acre.

An average return over 8,400 acres or 27.79 tons per acre.

One estate had an estimated crop of 40 tons all round for this year. On the other hand most liberal dressings of artificial manures are made, and it is claimed by one and all that this heavy manuring pays and pays well. The following figures give some indications of the amounts used :—

Estate 1.

Plant canes—800-1,000 lb. of artificial manure containing 12 per cent. N., 6 per cent. Phos., and 5 per cent. Potash.

Ratoons —800lb. of same manure.

Manure applied in two applications.

2. Same mixture but not quite so heavy an application.

3. 600lb. of the same mixture.
4. 400 lb. of the same formula at 1st weeding and 200 lb. of Sulphate of Ammonia 6 weeks later.
5. 800 lb. of same formula in two applications.
6. Use 128 lb. Nitrogen per acre.

The cost of this artificial manure is about $44.70 per ton.

They have no positive evidence that phosphates and potash are required and some estates such as Aguirre are using nitrogen alone. Some of the most progressive estates regard an application of 3 lb. nitrogen per ton of cane as a safe basis to calculate on.

Artificial manure is always buried.

Green Dressings.

We did not find green manuring a general practice; indeed it was usually claimed that green manuring did not pay. At Mercedita some cow peas were grown and later ploughed under.

Weeding.

Clean weeding was considered everywhere as an essential to successful cane cultivation. The fields are kept particularly free of weeds by numerous cheap weedings repeated at intervals of every 2 or 3 weeks. At one estate plant cane fields are given as many as 10 weedings, three units however often weed an acre per day.

Stripping of Canes.

Stripping of canes is not practised in Porto Rico.

Tractor and Ploughs in Use.

As stated above the Fowler Steam Cable outfit is to be found on most of the bigger estates and the conditions are ideal for their successful use. For second and subsequent ploughings tractors are in common use. The most popular type is the Rumely Wheel tractor known as the "Oil Pull" which is rated 20-35 H.P. and weighs 9,000 lb.

and cost $3,800. This is the only type of Oil Pull in Porto Rico, though the same firm makes a heavier type rated at 30-60 H.P. and costing $4,750.

The plough that is in common use with this tractor is the "Saunders" made by the Newell Saunders Plough Co. It is not unlike the "La Crosse" plough in general design but is even simpler in general construction and particularly so in the draw bar arrangements.

The Fordson tractor is also much in evidence and always pulling the "Oliver" No. 3 single mould-board plough.

We saw several Holt Tractors. At Cambulache they had six 5-ton tractors and six 10-ton ones. At Guanica they had several of both types. Mr. Brebnor, the Field Superintendent at Aguirre, and the "Oil Pull" representative in Ponce, were both familiar with the Holt tractors and they both expressed the opinion that the "Best 60" is a better tractor than the Holt 10 ton. The plough in use with the Holt tractor was always the "Saunders."

It may be of interest to mention that the "Storey" rotary plough was designed by Mr. Storey at Aguirre, and I am informed that the Fowler Company are engaged in producing this type of plough. An account of the Storey plough appeared in the "Louisiana Planter," for January 23rd, 1926, p. 68.

Tile Draining.

We found two estates—Mercedita and Aguirre—experimenting with tile draining. At Mercedita a considerable area (200 acres) has already been completed and the results are so encouraging that they are extending the trial. The method adopted on this estate was to open drains about 3 feet deep, lay down 4 inch pipes cover the pipes with about 6 inches of gravel covering this again with coconut leaves, and again placing a layer of gravel on the leaves bringing the last layer of gravel up to the cultivated level, say $1\frac{1}{2}$ to 2 feet from the surface.

At Aguirre they merely covered the tiles with a layer of gravel to prevent the joints from being blocked by silt.

The tiles are made of cement and sand, 7-1 mixtures and are not very costly. They have a Richmond Power Drain Tile Machine for turning out the tiles.

The advantage of tile draining is very obvious and should we decide to try a few acres it would be best to do so on our lighter black soils. I am doubtful whether tile draining will draw the water in our heavier soils, but this is a matter for experiment.

We saw no machine in use for digging the open drains.

Ratooning.

There is a considerable variation in the number of ratoon crops taken on the various estates of Porto Rico. In the Southern irrigated district we find only one ratoon being grown and in some cases not even one, one-third of area is planted in wet season plants, one-third in crop plants and one-third in 1st ratoons.

On one estate 80 per cent. of the plants are put in in the wet season and 20 per cent. in crop. About 40 per cent. of the plants are kept as first ratoons. On another, 50 per cent. in wet season plants and 50 per cent. in crop plants. First ratoons only. On yet another, no ratoons are run.

Value of Cane Lands in Porto Rico.

The reason given by the administrators of the South Coast Estates for the absence of ratooning is the high value placed on land and the high cost of irrigation. To make these estates pay, the highest possible yields per acre must be obtained and they have worked it out that this is best done by running plant canes only and occasionally a first ratoon.

Land in this neighbourhood has recently changed hands at as much as $1,000 per acre. The usual value is about $500 per acre; no one, however, is prepared to sell at this price.

At (a) Estate a charge of $1.45 per ton of cane was made this year for rent. At "B" rent and taxes amounted to $1.50 per ton.

In another district, however, land has not this enormous value and the charge for rent and taxes last year was 79 cents per ton or $21.91 per acre.

Taxation in Porto Rico.

With the high preference given the Porto Rican sugar grower, he is in a position to pay and is made to pay very high Insular Taxation, this may amount to as much as 40c. per ton of cane.

The Use of Cattle on Porto Rican Estates.

One of the most remarkable features of Porto Rican Estate management is the use they make of cattle and the almost complete absence of mules. It is impossible to stress this point too much. Cattle are to be seen everywhere and working daily. The native Porto Rican bullock is a splendid animal and is well handled. In the first place, the cattle are yoked differently to ours, being yoked to the horns. It is claimed by several managers who have experience of working oxen in both ways, that the animals have far better control of the load when yoked to the horns and the work they do in Porto Rico seems to bear this out. I argued that cattle could not be used on undulating lands, but having spent a day riding over one of the hilly estates of the Fajardo Company where I saw cattle working on grades that we would hardly send mule carts on I had to drop the argument. They work with complete success on some of the steepest hillsides.

The saving in fodder were we able to use more oxen would be considerable. They feed no concentrates to the working cattle in Porto Rico ; they live on grass and molasses. It is probably true that the grass in Porto Rico is superior to ours, but this would be overcome by our growing Elephant grass and Uba cane as fodder as they grow these grasses in addition to para and guinea grass in Porto Rico.

The Colono System.

A very considerable proportion of the canes ground at the factories is purchased from cane farmers called Colonos. These people are usually large growers owning

their own lands. They are paid on a sliding scale depending on (1) the sucrose content of the cane (each truck sampled separately) : and (2) the price of sugar.

Advances are made to these Colonos by the factory and 9 per cent. interest is charged. The supervision of the way these advances are spent is very close.

Cane Varieties.

The two most popular canes in Porto Rico are the B.H. 10/12 and S.C., 12/4, and the Estates are rapidly converting their whole holdings from other varieties to these two. Of the two the former is slightly the more popular, though it is claimed by many that under certain conditions the S.C., 12/4 is superior. There has been a complete change over to these two varieties within the last few years. On 90 per cent. of their soils it would be folly to plant anything else.

On one estate on the heavier soils they have had excellent results with a variety known as D. 433. The late Sir John Harrison in a letter stated that he had no record of this cane having been produced in Demerara, so that its origin is somewhat obscure. Its sucrose content is somewhat low but on the chance of its doing well on some of our red soils I have secured a few plants. Another variety that is doing well on the same estate is F.C., 436, and they kindly gave me a few of these for trial.

On several estates we found a fair amount of interest in the P.O.J. Seedlings. With the exception of P.O.J 2725—one of the newer importations—all these P.O.J. seedlings are 100 per cent. infected with Mosaic disease, but they are such vigorous growers that they show no ill effects. This is particularly so with P.O.J. 36 and 213. For this reason I did not consider it advisable to ask for plants from these estates with the result that I was only able to obtain 20 plants of each of these varieties from the Rio Piedras Experiment Station, where they have a few disease free plants.

I was able to obtain 20 plants each of the following varieties : P.O.J. 36, 213, 234, 826, 979 and 228, D. 1135 and Tuc. 507, 510 and 439.

So far as we were able to judge the P.O.J. 2725 is immune to the Mosaic disease, and the Agricultural Director of the Mayaguez Federal Experiment Station spared me 200 plants of this most promising variety and 15 plants of P.O.J. 2774, another promising variety.

We therefore have a good start with P.O.J. 2725.

SUGAR CANE DISEASES IN PORTO RICO.

The most serious diseases is the Mosaic but they have tackled the problem with energy and success on most of the Estates. Where the disease was very bad such as at Mayaguez in the Western district they had to resort to the growing of Uba cane which is immune. By the planting of clean "seed" only and followed by careful roguing it is being got rid of from many estates. On the Estates in the Northern district we saw plenty of Mosaic even in fields of B.H. 10/12, and S.C. 12/4, recently planted, but these varieties showed little ill effect from the disease. It will be very interesting to see whether they will eventually suffer. We could see no evidence of vigorous measures being taken for its eradication.

Another disease which is causing anxiety is the gummosis. Certain varieties are very susceptible to this disease, particularly H. 109, D. 625, Ba-6032, etc. As this disease is not known in Trinidad, great care will have to be taken to prevent its introduction.

There is also an Aphis which does considerable damage to Uba cane in Porto Rico and which is not known in Trinidad. Care will have to be taken to prevent its introduction with the plants I have brought in.

To achieve complete isolation and as a measure of precaution all these varieties have been planted on Mr. Higgins' Estate at Macqueripe, where no canes are grown commercially.

Central Aguirre have engaged the services of a whole-time Entomologist to study the various insect pests which cause them considerable losses. The chief of these are the small moth borer (*Diatraea saccharalis*) and the white grub (*Lachmostema* sp.). The entomologist is mainly engaged in looking for and introducing parasites from other countries.

The same central has also joined with Central Guanica to employ a plant pathologist to study the plant diseases of the sugar cane in Porto Rico.

LIMING AND LIME PULVERS.

It is the general practice on estates on the North Coast to lime their soils and applications of about 2 tons of ground lime-stone per acre is made at each re-planting.

Many of the estates have a lime-stone crushing plant of their own and the following particulars are given of the one seen at Constancia :—

Name of Pulver : Jeffrey Lime Pulver.

Makers : The Jeffrey Mfg. Co., Columbus, Ohio, U.S.A.

Size : No. 3.

Capacity : 1½ tons per hour.

R.P.M. : 1,800.

Motor : 50 H.P. (25 H.P. would be sufficient.)

Size of stone : 8' x 3".

Cost installed in Porto Rico : $1,400.

The lime pulver at Aguirre was more elaborate.

The one at Fajardo has a capacity of 4 tons per hour, also made by the Jeffrey Company.

THE MAYAGUEZ FEDERAL EXPERIMENT STATION.—

We spent one afternoon going over this station with Mr. Davis, the Acting Director. Mr. Davis is a trained plant breeder and is devoting his whole time to turning out cane seedling.

The most promising seedlings we saw were crosses between P.O.J. 2725 and S.C. 12/4. These crosses showed true hybrid vigour and should produce some excellent new seedlings. It is too early as yet to judge of these canes as they are only in their first year.

The Insular Department of Agriculture is a formidable organisation with head office in San Juan. The Experiment Station is situated in Rio Piedras some 10 miles outside the town, and here they carry on their sugar cane experimental work and have their laboratories—Chemical, Entomological and Mycological.

They have a very comprehensive collection of sugar cane varieties numbering several hundreds. Each is carefully labelled.

They also carry on manurial and cultural experiments and the results are published from time to time in the form of a Bulletin.

At Mayaguez there is in addition to the Federal Agricultural Department, an Agricultural College supported by the Insular Government.

DEPARTMENTAL NOTES.

Professor J. Sydney Dash, B.S.A., late of the Imperial College of Tropical Agriculture, arrived in the Colony on July 14, and assumed his duties as Director of Science and Agriculture the following day.

Professor Dash who has had a distinguished career as an agriculturist, received his early training under Mr. J. R. Bovell, I.S.O., late Director of Agriculture, Barbados. He took his degree with first class honours at McGill University, Montreal, specializing in plant pathology. After holding several positions in Canada he returned in 1914 to Barbados to fill the post of Assistant Director of Agriculture. In 1918 he accepted the invitation of the sugar planters of Guadeloupe of the French West India Islands to visit that island and organise and direct their Experiment Station. He spent three years there and then returned to Canada to take up the position of Tobacco Specialist in the Department of Agriculture at Ottawa, investigating tobacco varieties, diseases, etc. Later he held the post of Supervising Botanist in the Seed Branch of the same Department. When the Imperial College of Tropical Agriculture was started in October 1922, he was offered and accepted the position of Professor of Agriculture. His duties entailed lecturing on a wide range of crops, with special attention to the major tropical industries. In addition he carried out important investigations, notably on sugar-cane, bananas, tobacco, cover and rotation crops generally and has contributed freely to the pages of *Tropical Agriculture*, the Journal of the Imperial College of Tropical Agriculture.

Professor Dash is greatly interested in agricultural research and has visited the more important Experiment Stations and Institutions in England, Canada and the United States of America.

A meeting of the staff was held at the head office, Broad Street, on Tuesday, July 26th at 2 p.m. The Director presided, and various items of a domestic nature affecting the Department were discussed.

The Director attended a meeting of the Georgetown Chamber of Commerce on July 22. He promised to co-operate with the Chamber in all matters which might come within the scope of his Department.

The Director visited His Excellency the Governor's ground nut cultivation on July 27. A report of the visit is given elsewhere in these columns.

The Government Economic Biologist paid a visit to the North Western District on July 19, to investigate an attack of "Cockles." A short note on his visit appears in this issue.

We are pleased to record the visit of Mr. H. C. Sampson, C.I.E., Economic Botanist at Kew, who arrived in the Colony on July 31, and to whom special reference is made on page 241 of this issue.

Meteorological Data—January—March 1927.

Recording Stations & Months.	Rain-fall. Total Inches.	NUMBER OF DAYS OF RAIN: Under ·10 Inch	·10 to ·50 Inch	·50 to 1.00 Inch	1.00 Inch to 2.00 Inches	Above 2.00 Inches	Total days.	Evapo-ration. Inches	Air Temperature and Humidity. Air Temp. Maximum.	Minimum.	Mean	Humidity.
Botanic Gardens.												
April ...	2·76	3	5	1	1	...	10	5·12	86·2	76·0	81·1	77
May ...	18·57	6	11	4	5	2	28	3·83	84·7	75·9	80·3	82
June ...	8·34	4	14	7	...	...	25	3·09	84·5	75·5	80 0	83
Totals	29·67	13	30	12	6	2	63	12.04				
Means.	...	...	...	...	...	...	...	...	85·1	75·8	80·5	71.
Berbice Gardens.												
April ...	5·37	4	5	3	1	...	13	...	88·1	74·5	81·3	77·
May ...	15·84	3	10	7	6	...	26	...	86·3	74·7	80·5	81.
June ...	11·98	4	12	3	4	...	23	...	87·4	74·7	81·0	81·
Totals	33·19	11	27	13	11	...	62	...				
Means.	...	...	..	...	...	...	...	. .	87·3	74·6	80·9	79·
Onder-neeming.												
April ...	5·52	1	...	1	4	...	6	...	89·0	74·0	81·5	...
May ...	19·10	1	3	2	7	3	16	...	89·0	73·0	81·0	...
June ...	14·50	1	5	8	4	1	19	...	88·0	72·0	80·0	...
Totals	39·12	3	8	11	15	4	41	...				...
Means.	...	...	...	...	...	...	...	...	88·7	73·0	80·8	...
Mora-whanna. N.W.D.												
April ...	4·15	...	6	1	1	...	8	...	...	...	...	...
May ...	15·03	...	9	5	5	1	20	...	...	...	...	...
June ...	26·87	1	10	8	8	2	29	...	...	...	...	...
Totals ...	46·05	1	25	14	14	3	57	...	...	...	..	...

ATTENDANCES AT THE DISTRICT GARDENS

Year.	Bourda.	Belfield, E. Coast.	Stanleytown, New Amsterdam.	Suddie, Essequibo.	Den Amstel.	Houston, E. Bank.	Wakenaam.	Total Attendances.
1912 ...	5,514	4,395	3,302	2,100	2,544	2,156	1,718	21,726
1913 ...	5,156	4,535	2,519	3,399	2,568	1,836	1,319	21,332
1914 ...	4,243	3,869	2,443	3,025	1,791	1,653	1,533	18,577
1915 ...	1,123	1,006	769	59	503	339	401	4,209
916 ...	4,705	1,161	1,510	225	623	2,251	1,297	12,026
917 ...	4,991	2,820	1,366	3,297	1,186	2,564	1,663	17,086
918 ...	4,834	3,081	1,653	2,671	2,162	2,790	2,067	19,258
919 ...	4,769	2,425	1,582	2,798	1,851	2,480	1,556	1,4617
920 ...	6,285	2,312	1,665	2,525	2,532	3,228	2,148	20,695
21 ...	5,671	1,968	1,642	2,629	1,949	2,539	1,610	18,008
22 ...	3,557	1,841	1,105	1,593	1,525	1,522	1,397	12,950
23 .	4,038	2,780	1,595	1,934	1,953	2,137	1,951	16,388
24 ...	4,123	2,827	1,103	1,789	1,678	2,146	1,664	15,330
25	3,317	2,755	1,580	1,819	470	1,663	1,597	13,201
26 * ...	1,732	2,627	1,219	2,172	364	1,268	1,600	10,982
7 1st Qr.	414	768	346	683	266	598	598	3,673
2nd Qr.	245	174	252	409	249	327	527	2,183

* Decrease in attendances caused by very unfavourabl...

EXPORTS OF AGRICULTURAL AND FOREST PRODUCTS.

Below will be found a list of the Agricultural and Forest Products of the Colony exported during the first six months of 1927

The corresponding figures for the same period during previous years and the average for the same period for nine years previous to that are added for convenience of comparison.

Product.	*Average 1916-24.*	*1925.*	*1926.*	*1927.*
Balata, cwts. ...	3,081	3,330	4,457	2,956
Cattle-food (Molascuit) tons	669	692	430	241
Cacao, cwts. ...	10	None	None	None
Cattle, head ...	219	357	11	4
Charcoal, bags ...	23,270	16,887	16,344	17,227
Citrate of Lime, cwts.	88	None	None	None
Coconuts, thousands...	1,301	603	422	101
Coconut Oil, gals. ...	12,258	14,209	12,550	10,280
Copra, cwts. ...	2,200	7,670	28,478	8,529
Coffee, cwts. ...	3,338	3.681	6,445	1,892
Essential Oil of Limes, gals. ...	82	81	153	207
Firewood, Wallaba, etc., tons	4,092	3,476	4,470	4,725
Gums, lbs. ...	1,526	None	866	None
Hides, No. ...	2,763	5,342	3,976	3,087
Kola-nuts, cwts. ...	2	None	None	None
Lime Juice, gals. ...	3,583	2,479	2,511	3,852
Lumber, ft. ...	86,713	44,288	116,988	122,501
Molasses, gallons ...	40,630	503,502	592,424	1,260,475
Pigs, No. ...	162	516	309	299
Railway sleepers, No.	6,541	23,515	5,184	8,796
Rice, tons ...	4,972	3,580	1,725	4,627
Ricemeal, tons ...	15	None	None	None
Rubber, cwts. ...	33	None	146	203
Rum, gallons ...	1,370,559	725,522	480,129	638,397
Sheep, head ..	26	6	None	1
Shingles, thousands	1,006	1,077	766	1,118
Sugar, tons ...	40,425	41,248	41,498	46,302
Timber, cub. ft. ...	66,518	134,535	136,272	79,272